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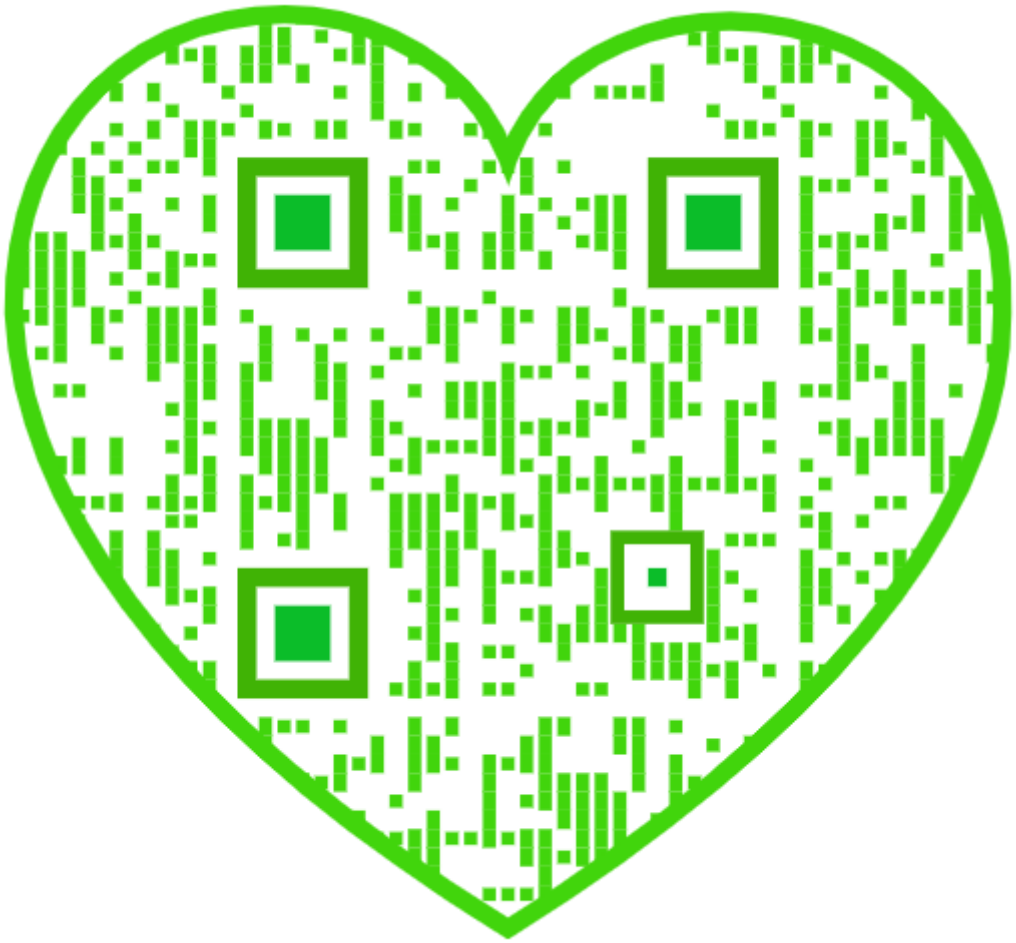
PRINTING MACHINES
AND
MACHINE PRINTING

WYMAN'S TECHNICAL SERIES



THE

Principles and Progress

OF

PRINTING MACHINERY

BY

JOHN SOUTHWARD,

AUTHOR OF

"PRACTICAL PRINTING," ARTICLE ON TYPOGRAPHY IN "ENCYCLOPÆDIA BRITANNICA"; EDITOR "PRINTERS' REGISTER," &C.

WITH AN ACCOUNT OF

MODERN PRINTING MACHINES

(Based upon "Typographic Printing Machines")

BY

F. J. F. WILSON,

AUTHOR OF "STEREOTYPING AND ELECTROTYPING," &C.

SECOND EDITION.

LONDON:

E. MENKEN, BURY STREET, NEW OXFORD STREET, W.C.

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GREAT QUEEN STREET, LINCOLN'S INN FIELDS,
LONDON, W.C.

PREFACE.

ANY — especially among the younger generation of printers—are, in regard to the mechanics of their business, very much in the same frame of mind as Wordsworth's rustic, of whom it was said that "a primrose by the river's brim, a yellow primrose was to him, —and nothing more." They look at the beautiful machines which now with so much precision, effectiveness, uniformity, and extraordinarily increased speed, do the work that was previously done by men of long training, exercising every care, and exerting all their physical strength, —they see these machines inking the type, pressing the paper, delivering the sheets even, with the neatness of the neatest human hand,—and then regard the apparatus that performs so many complicated and delicate movements as a mere collection of cylinders and wheels, cranks, levers, cams, and racks. How all these mechanical appliances came to be adopted—how they have fallen each into its place— how the whole has been evolved from the rudest contrivances and developed from the most cumbrous devices—they know not. This is the frame of mind of one of the heroines of Mrs. Beecher-Stowe's already half-forgotten novel. When the parentage of Topsy is inquired into, she confidently expresses the belief that she

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had neither father nor mother, but "'spects she grow'd." As to the author or inventor of our machines, too many of us are quite content to be supremely ignorant; we only know that there those machines are ready for our use; and if more are wanted, well, we "'spects they'd grow."

In the following short series of chapters an attempt, necessarily of a slightly desultory character, it must be confessed, will be made to show the evolution of the chief parts of modern machines; to describe the principles on which their design has been settled, and to point out the progress accomplished as each successive step in advance has been achieved. Merely historical facts will be omitted, except when it is found that their bearing is of special importance.

To this general matter are added accounts in detail of most of the printing machines now in use—this matter being chiefly reprinted, with additions, bringing it as far as possible up to date—from Mr. F. J. F. Wilson's "Typographic Printing Machines and Machine Printing" recently forming one of the volumes of "Wyman's Technical Series." The work of revising this matter has been chiefly done by Mr. J. C. Millington, a former Honours Medallist of the classes of the City and Guilds of London Institute for the promotion of Technical Education, and now one of the registered teachers of that excellent organisation.

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PART I.

INTRODUCTORY.

CHAPTER I.

I.—DIFFERENCE BETWEEN A "PRESS" AND A "MACHINE."

IT may, first of all, be asked why it has become customary to call one kind of apparatus a press and another a machine, when both do the same thing, and when a press is, in reality, a machine, and one, moreover, of some complication. The only reason that can be given is conventional use. In America all printing-machines are called presses. In France the distinction is between the hand-press and mechanical press—*presse à main* and *presse mécanique*, which is also founded, not on any logical principle, but on ordinary usage and acceptation. In Germany they speak of the *hand-presse* and the *schnellpresse*, or "quick" press; drawing the line at the speed of operation rather than the nature and design of the contrivance, which, again, is not scientific. The only answer to this question is, then, that the term "machine" has always been accepted, since the first inventor adopted it, to designate a more automatic apparatus than the "press" for type-printing.

Let us now consider how the first machine differed from the hand-press, and why the Germans make the distinction—so well founded on experience—that the machine is a "fast" or rapidly-working press. Here we are again reminded of the convenient creed of Topsy. Hitherto writers have been content, one after another, to repeat that Nicholson's patent of 1790 was the origin of printing machinery, that at one stroke he invented all the essentials of modern appliances. In any other department of invention such a conclusion would not be accepted, especially in these days of belief in evolution and development. No invention, it is quite commonplace to say, ever emanated

as a completely original proposal from the brain of its inventor. Printing—that is, movable-type-printing, or typography—was preceded by block-printing, or xylography. European block-books were preceded by the Chinese block-prints, and were a development of the method employed by the old Romans, who themselves printed with ink. The Assyrians, before them, printed records on plastic clay, which may have been suggested by footprints in the ground, such as would be visible as early as the world itself was inhabited.

The first press was probably copied from the wine-presses or domestic linen-presses of Mediæval times, and was only improved—not created—by the early printers, who added the tympan and the frisket, and the means of moving the carriage and actuating the screw by the press handle.

II.—ORIGIN OF AUTOMATIC MACHINERY FOR PRINTING.

Strange as it may at first sight appear, it is to the history of calico-printing that we must look for the origin of machine-printing on paper for literary and graphic purposes. For many years calicoes were printed by what were known as "hand-blocks." The material was stamped by means of a pattern raised in relief on the block, which was charged with the composition or pigment to be transferred to the fabric. As an improvement on this, a moistened roller charged with dye was passed over the material. The increasing demand of a rapidly-extending trade led to a more expeditious method being adopted, and about the year 1750 a cylinder machine was introduced for the purpose. As the first-mentioned appliance is analogous to printing on paper by the ordinary press, except that the relative position of the material and the pressing surface are reversed, so the two cylindrical methods are analogous to rotary printing, as the design to be impressed is cylindrical in form and revolves, pressing upon the material brought into contact with it. The third method, however, differs in two respects. The design is incised into the cylinder instead of being in relief, and the colours which the piece of stuff is to receive are not directly printed on it. The cylinders are charged with mordants which in an after process take them up and fix them.

About 1760 this process, enormously quicker than anything previously invented, was brought into actual use. It revolutionised the trade of calico-printing, and did the work with a speed and a cheapness that before were impossible. The question seems to have suggested itself to several inventors, whose specifications are preserved in the Patent Office,—Why should not letterpress printing be done in the same way, or in some way nearly similar? What was the insuperable difficulty—if there were any—in impressing with a roller a piece of paper instead of a piece of cotton?

At this time there were in use the wooden press of the primitive construction and that "improved" by Blaew. The tediousness of impressing a piece of paper by the apparatus must have caused amazement to any non-practical man who had watched or heard of the plan of printing with a cylinder, which, in comparison, seemed simplicity itself. We may, to accentuate the comparison, and to show the reason why the machine is so much quicker than its predecessor (which will be the subject of the next chapter), enumerate the several operations necessary in printing at a hand-press. They are:—

1. Inking the balls, or, as at present, the roller.
2. Inking the form.
3. Laying the sheet on the tympan.
4. Flying the frisket, and folding it and the tympan down on the form.
5. Running in the form under the platen.
6. Taking the impression by depressing the platen.
7. Running out the form.
8. Lifting the tympan and frisket.
9. Releasing the sheet and placing it on the bank.

A person unacquainted with the nice details involved in nearly all these processes would, no doubt, jump to the conclusion, after seeing a calico-printing machine, that by making the design, or form to be printed, cylindrical, and by inking it by some cylindrical appliance, the sheet might be quickly impressed without a third of the trouble involved in hand-press printing and in an almost infinitesimally short space of time. As a matter of fact, this idea has been actually realised, but only by the

patient perseverance of hosts of inventors,—and the expenditure of enormous sums, over a period of more than half a century, which has been required to accomplish it.

That this assumption of the connexion of the origin of machine printing with the invention of cylindrical rotating machines is well founded, is shown by the fact that the earliest projectors coupled together the two arts, and these improvements related to machinery which, in its principles, at least, was supposed to be capable of performing both indifferently. They state so much in their specifications of patents. Space need be occupied in detailing only one of these projects. Thus, in 1772, a Joseph Adkin, his son, and Thomas Walker, patented (No. 1,007) "a new machine or engine for stamping or printing of paper, silk, woollen, cotton, and linen cloths and other articles made of silk, wool, and cotton, whereby the printing on such materials would be greatly facilitated, and rendered much less expensive and more perfect and exact." The press was composed of three cylinders, arranged vertically. The upper one, 6½ in. in diameter, acted as a pressing cylinder; the middle one, to which power was applied, was 3 in. in diameter, and was the printing roller; and the lower one, of 7 in. diameter, was an inking or colouring roller, partly immersed in a colouring-trough. There are no drawings attached to this specification, and it is difficult to conjecture what the inventor would do with a printing roller of such small circumference. There, however, is the idea of calico-printing proposed to be applied to the letterpress printing.

CHAPTER II.

NICHOLSON AND HIS PROJECTS.

WE now come to the project which was destined to revolutionise the art of printing, for it showed in what direction progress was possible. Nevertheless, like the patents previously mentioned, it was founded upon the idea that letterpress printing might be done in the same way as calico-printing. This is evident from its title —"a machine or instrument on a new construction for the purpose of printing on *paper*, linen, cotton, woollen, and other articles, in a more neat, cheap, and accurate manner than is effected by the machine now in use." As a matter of fact, there was no "machine" whatever for printing on paper, unless we assume that it was for paper-hanging; but the patentee meant, no doubt, to assimilate as far as practicable the two kinds of printing.

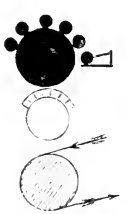

Fig. 1.—Nicholson's Arrangement for Arched Type.

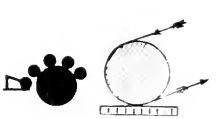

Fig. 2.—Nicholson's Arrangement for Common Type.

This patent was taken out in 1790, and bears the official number 1,748. The patentee was William Nicholson, born in 1758; died, 1815. His career may be described as that of a sanguine and unbusinesslike, an unsuccessful and unfortunate inventor,—withal a man of great ability, ingenuity,

and perseverance; one well acquainted with physical and mechanical sciences, and of considerable literary ability. He began to devote his attention to printing machinery about 1788, it is said; at any rate, in 1790, he took out the patent of which the heading has been given above. It describes several distinct inventions, perhaps because there was thereby saved the cost of stamps on several grants of letters patent. These inventions related to printing on several textile fabrics, as well as on paper, but the details are here irrelevant.

The ideas of Nicholson were to substitute cylindrical pressure for the platen pressure, then exclusively adopted. He describes two different kinds of apparatus in which this cylindrical pressure can be employed. In one, the form to be printed from was on the flat, and in the other it was in the shape of a cylinder also. In each case the rolling was to be performed with rollers. This is obviously the calico-printing idea; but the patent derives its importance and interest from the provisions for utilising these principles, and adapting them to the exigencies of letterpress printing. We may begin with a consideration of the principles of the flat-bed and cylinder invention. These are clearly shown in the drawings accompanying the patent. The type form is laid on the table forming part of the carriage and moving backward and forward on rails. At one end are two cylinders placed longitudinally, the top one being the impression cylinder, and the lower one a bearing roller for carrying the carriage. The impression cylinder is faced with cloth, and is geared with the table. The chase containing the type is laid on the bed. About the middle of the press is a large "colouring roller," with small distributing rollers around it. At the other end of the carriage is a cylinder faced with leather, lying across an ink block.

When the letter is drawn beneath the inking roller it receives ink, and when it has passed on to a point near the impression cylinder, a workman turns down a tympan with paper upon it. The type then passes under the cylinder, which presses it. Afterwards the workman takes off the paper, and leaves the tympan up. When the carriage has passed to its extreme distance, an arm extending from the

upright frame, bearing the impression cylinder, touches a lever attached to the ink-box and raises a cylinder, by which means it dabs against the distributing rollers and gives them a small quantity of ink. There is an arrangement for lifting the cylinder so as to escape the form when the latter is making its return journey. The sheets are taken up by grippers, carried round the impression cylinder, and then let go.

The chief essential features of modern printing machines are foreshadowed in this remarkable patent. There are the reciprocating table, and the cylinder geared to it; the inking of the form by means of long rollers, instead of the old balls; the distribution of ink upon these rollers by means of subordinate rollers; the ink-duct at the end, with its roller supplying a small but regular quantity of fresh ink at each revolution; the inking of the form and its passage beneath a revolving impression cylinder; the return of the form to be inked without touching the impression cylinder; the grippers for seizing and carrying round the sheet, and releasing it.

Another part of the invention relates to what may be called rotary printing. The type form as well as the impressing cylinder revolve, the paper being pressed between the two. This part of the invention was not so completely worked out as that referring to the flat-form machine; but the following details are, among others, given in the specification :—

The paper intended to be printed on—previously wetted, if necessary—was to be passed between two cylinders, or segments of cylinders in equal motion, one of which had the type form, or printing surface, attached to its surface, and the other was to be defaced with cloth or leather, so as to take off an impression of the colour previously applied.

Or, the printing surface previously coloured, was passed in contact with the material, wrapped round a clothed cylinder; or the clothed cylinder, with the material round it, rolled over the printing surface previously coloured. Or, the printing surface coloured by a colouring cylinder, rolled along the material spread out upon an even plane.

So much for the pressing cylinder in its relation with the printing cylinder. The latter was to become "the

form,"—not flat, but cylindrical; the types were to be applied to its surface. There a formidable difficulty presented itself, for ordinary rectangular types are not so adapted. Nicholson attempted to surmount it in this way. He proposed that the types should be scraped on one or more sides in a "finishing stick," whose hollowed part was less deep at the inner than the outer side. The purpose accomplished by this method of scraping is that of rendering the tail of the letter gradually smaller the more remote it was from the face. Such letter, it was claimed might be firmly "imposed" on a cylindrical surface—that is, like the stones in an arch. These types were to be imposed in chases of wood or metal adapted to the surface of the cylinder. As an alternative to the use of these wedge-shaped types, it was proposed that stereotyped plates might be bent round the cylinder. For reasons which will appear hereafter, these further details concerning the inking arrangements should be given. The ink was furnished to the printing surface by a "colouring cylinder," covered with leather, or the dressed skins which printers called felts, or with woollen or linen, or cotton cloth, and stuffed with horsehair, wool, &c., defended by leather or oilskins. These cylinders, covered with ink, were to roll over the forms, or the forms were to apply themselves to the cylinders.

As it was necessary that the colouring matter should be distributed very evenly over the surface of the cylinders, there were to be two or three small rollers applied longitudinally against the colouring cylinders, so that they might be turned by the motion of the latter.

No machine, according to the terms of this specification, was ever built in England; but an American amateur printer, Dr. Kinsley, is stated to have made one, which worked well. Even if this is correct, his countrymen failed to carry out the idea. Nicholson, after practising for some time as a patent agent and compiler of specifications for other inventors, died in a debtors' prison in great distress. If we are asked why this invention was never carried out by its inventor, the best answer would appear to be that he was unable to get the necessary financial assistance. Its chief features, however, were utilised by the inventor of the first practical machine, as will be seen when Kœnig comes to

be treated of. Intervening between his achievement and Nicholson's mere project, there is, however, in the records of the Patent Office, one noteworthy proposition which has also been strangely overlooked by the historians.

In 1807, John Brown took out a patent (No. 3,047) for certain improvements in the construction of the press. As Nicholson's ideas were the germs of practical improvements later on, in the form of cylinder machines, so Brown's ideas may be considered, although very crude, to have foreshadowed the later platen machines. A platen was drawn down by a screw, actuated by a shaft to which motion was given by a winch. The platen recovered itself by a weight or spring. A cast-iron bed carrying the form slid out below an inking roller. This roller was padded with flannel, &c., and covered with parchment or other material to keep the ink from penetrating. A cylinder having received the ink from the trough underneath it, and had it distributed by a small roller in contact with it, supplied the inking roller, and the latter revolved and fed the types "by the motion of the spindle which moved the bed"; *i.e.* the rounce, from which also by means of a strap, the large roller and its distributor were driven. This inking apparatus the inventor regarded as "his principal improvement." In 1809, Brown took out another patent (No. 3279) for "certain new improvements in a machine or press for letterpress printing." The form was fixed in the centre of the press. There was an upper bed or platen rigidly connected with a carriage which ran on a tramway above the press, and was drawn over the form by a cord passing over a roller turned by a hand lever. The bed-platen was confined under strong pieces of iron fixed to the frame, and returned by means of a weighted cord. The impression was given in one of three ways:—

1. By the rising of a vertical rack below the bed, by motion imparted through a series of levers from a rounce barrel; or,

2. By a screw, acting upwards; or,

3. By a roller fixed on the bottom part of the carriage, and which rolled over the tympan and types and gave the impression.

The inventor says:—"I apply two tympans, one on each

side, so that two workmen may use the same form, and by this mode am enabled to do nearly double the work in the same time."

Particulars are not available as to the actual performance of a machine of this kind. It very curiously anticipates the platen and the double platen, invented many years afterwards, as will be seen eventually. This invention has been entirely overlooked by writers on the subject of printing machinery. We may therefore take it that the invention was a failure, or rather, that its author was unable to surmount the difficulties which, as practical men may now see, —after long years of experience, it must be remembered,— were inherent in his plans.

We have now endeavoured to show that the idea of printing machinery, as distinguished from that of the hand-press, seems to have arisen exteriorly to the business of printing itself; how the calico cylinder machine suggested the letterpress cylinder machine; and how Nicholson attempted to make the adaptation. We have tried to trace back the first proposed "platen" machine to that of the forgotten inventor, Brown. Each of these patents was granted for an abortive invention, yet one which undoubtedly led to splendid results within the next quarter of a century. In the following chapter we turn from mere projects to performances—from machines "on paper" to machines that actually printed, and shall show why this realisation of theory, in fact, so soon followed.

CHAPTER III.

KOENIG AND THE FIRST PRACTICAL MACHINE.

THE next patent, after Brown's, mentioned in the preceding chapter, for the invention of a printing machine, was granted on March 29, 1810, to Frederick Koenig. This marks the commencement of the actual manufacture of machines, not only in Great Britain, but in any part of the world.

It is no part of our design, as already stated, to give biographical or merely historical facts, except when they are necessary to elucidate or illustrate the progress of invention. Hence we pass over the very interesting career of Koenig.* Suffice it, therefore, to say that he was born in 1774, at Eisleben, in Thuringen. After passing through the usual curriculum of German collegiate life, he was apprenticed to the celebrated Leipzig printer, Imanuel Breitkopf. Koenig duly served his time, and for nearly a year afterwards worked as a pressman. When about 29 years of age he began to turn his attention to the application of machinery to printing. His first idea was not to invent an entirely new apparatus, but to improve the existing form of hand-press. Experimenting at Suhl, in 1803, with wooden models, he endeavoured to make the inking of the type and the distributing of the ink more automatic by causing the form to travel backwards and forwards, being brought meanwhile in contact with leather inking rollers. Failing to obtain assistance

* His life has been written in: "Friedrich Koenig und die Erfindung der Schnellpresse. Ein biographisches Denkmal."—Von Theodor Goebel. Large 4to., viii., 280. Plates. Stuttgart, 1883. In 1885 the work was translated into French by M. Paul Schmidt (Paris, 8vo.). It is, however, necessary to revise some of the assumptions of Goebel by the able essay, in the form of a review, by Mr. William Blades, which appeared in the *Printers' Register*, vol. xxiii. (1883-84).

or encouragement in his own country, he went to Russia, where he met with disappointment, and then came to England, arriving here in November, 1806. At first he got employment as a journeyman printer, but managed to become acquainted with Bensley, a very eminent printer at that time. In 1807 there was drawn up an agreement to the effect that if the "entire new method of printing by machinery," which Koenig had "discovered," answered all the purposes claimed by the inventor, Bensley was to "purchase the secret." For two and a half years Koenig laboured at the improvement of his machine, but no satisfactory results were obtained. In 1809, Mr. Walter, of the *Times*, was applied to by Koenig to patronise his invention, but the proposition was declined. The machine was a mere modification of the *old screw-press*, and the utmost increase of speed expected was to 400 impressions per hour. About this time Koenig was joined by his friend and countryman, Andrew Bauer. In consequence of Walter's refusal to participate in the enterprise, Bensley, Koenig's partner, laid the scheme before the well-known printers, George Woodfall and Richard Taylor. They consented to join the partnership, and to find money for further experiments. These led to the construction of the machine which was the subject of the patent of 1810.

Notwithstanding the great interest attached to the machine protected by this patent, it need not occupy many lines here, for it was hardly a "machine" in the sense in which we are now using the word. It was a platen screw-press, in fact. In the April of 1810 it printed 2,000 or 3,000 impressions of a sheet of the *Annual Register*. There is no record of any other work being done by it, so that it was probably soon abandoned—the results not being, in regard either to quality or to quantity, equal to the expectations of those who were interested in its construction. The press, however, will always be invested with the interest arising from the fact that it first showed that sheets could be printed by a "machine," differing in design and arrangement from the hand-press.

So far Koenig was on the "wrong tack." Why? Because he was trying to make an improvement on what was hardly capable of improvement His ideas did not

extend beyond the modification of the screw-press, to which he, as a journeyman printer, was accustomed. Herein he acted as other men had done in other lines of invention—he realised the necessity and the possibility of improvement of the appliance then in use. William Nicholson, who was not a printer, was fettered by no such habit—he boldly devised a revolutionary change. Had he been a "practical" man, he would probably have never thought of such an entire departure from the customary appliances and methods of the trade.

Soon after the patent for the platen screw-press was taken out, Koenig was brought into contact with Nicholson, and learned what he had patented twenty years previously. In the result he abandoned all the methods which he had previously been following. He gave up the screw and platen altogether, and thenceforward devoted himself to cylinder printing. How his next machine differed from

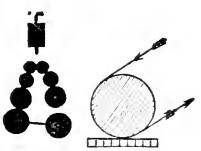

Fig. 3.—Kœnig's Single Cylinder for One Side of Sheet.

the designs of Nicholson, as embodied in the patent of 1790 (to which Koenig had access), may be judged from the following details of its construction.

The Carriage and its propulsion.—The form was fixed on a bed, consisting of a cast-iron plate, which ran to and fro—that is, had a reciprocating motion—on a table or carriage. To diminish the effect of the return, there were strong spiral springs fixed at each end of the machine, acting as buffers. The object of the to-and-fro motion was successively to bring the type alternately under the action of the inking rollers and of the impression cylinder, when, a sheet of paper being superimposed, it was printed.

To move the carriage to and fro, Koenig used the *double rack and tumbling pinion*, precisely as we have it at this day. Underneath the table is a toothed wheel which works between two racks. The lower rack is fixed to the bottom

part of the frame, and the upper attached to the under side of the table. This wheel is made to traverse backward and forward upon the fixed rack, by a connecting rod, from a stud wheel upon the main shaft. From the nature of the motion the table can have a double or increased motion to that of the wheel.

The Cylinder.—The impressing apparatus was peculiar, at any rate to present ideas. In the centre of the machine was a printing or pressing cylinder, from which in three places, at equal intervals, a portion of the surface was removed. The cylinder rotating in one direction, this removal of surface was done to enable the form to pass freely beneath it on its return to approach the inking rollers.

Upon this cylinder were three tympans, described as resembling the inner tympans in the common press. The cylinder was moved for each impression one-third of a revolution and then stopped. The first start carried the sheet round and secured it by winding the "frisket" (to be referred to presently) upon it; with the second the impression was given and the sheet thrown off; and with the third the empty tympan was coming up for a fresh sheet.

To accomplish this intermittent or stop motion a peculiar train of gearing was used. On the outer end of the cylinder shaft was placed a "born" gear, which divided into thirds. Directly below was a pinion, to which was bolted a sector. This moved the cylinder one-third of a revolution at each full turn made by itself. Thus time was afforded to feed the sheet to one of the three blankets, this being done by points fastened on the blankets in exact imitation of the method used on the hand-press.

Grippers for seizing the sheet to be carried round the cylinder had, as we have already seen, been mentioned in Nicholson's patent, but they were not adopted by Koenig. A continuous motion to the cylinder in the absence of these would not afford the opportunity to feed, or lay the sheet, hence the intermittent or stop motion of the cylinder was applied.

Why has Koenig's invention been held as of such importance that Mr. Blades and others give him a niche in the Temple of Fame, second only to that of Caxton, who brought

printing to our country? His apparatus was cumbersome and clumsy, and some of its arrangements would be sneered at by any ordinary modern mechanic. The reason it was of inestimable importance was, first, that it at once enabled 1,000 copies to be printed in one hour, whereas all existing apparatus could only produce a fourth of that number; second, that its principle was capable of almost unlimited development, and has been developed, until we have at the present day machines that print 2,000 copies perfect per hour.

The question may arise, Why was the cylinder machine capable of doing so much more than the platen-press? Inconsiderate people will say because it had a cylinder, a reply which will not bear much examination. In order to intelligently appreciate what it was that Koenig effected, even in this comparatively rude machine, it is necessary to consider how it differed from the only printing apparatus then in use, the hand-press.

In a hand-press there are six essential parts.

1. The table, which runs in and out by means of the rounce and girths, and thus carries the form to and fro from the platen.

2. The tympan, in which the blanket is placed to give elasticity to the pressure.

3. The frisket, to keep the sheet in its place when it is laid on the tympan.

4. The platen, by means of which the pressure is given to the type.

5. The screw, lever, or other mechanical appliance, by which the platen is depressed.

6. The inking table, with its roller and ink receptacle of some kind.

The other parts are merely subordinate to these, and serve to steady or strengthen their operations.

In Koenig's machine some of these six essential parts of the press were retained, while others were either modified or rejected altogether.

1. The table carrying the type to and from the point of pressure remained the same, but it was made to reciprocate mechanically by means of the racks and pinion already referred to. The inking table, instead of being a

separate adjunct, formed part and parcel of the type table, so that, as the latter moved to and fro, some of the inking rollers which came into contact with it at each traverse might serve to distribute the ink, and others might ink the type.

2. The platen, the tympan and its frisket, as well as the screw or lever by which the pressure was given, were all combined on the impression cylinder. The blanket was placed round this, and a series of endless tapes applied to keep the sheet in its place, instead of the strings previously stretched across the frisket. The pressure was given by the rotation of the cylinder by making its gear into the rack on either side of the impression-table below.

Hence it will be seen that the *six* essential parts of the hand-press were combined in the *two* essential parts of the printing machine. In the old hand-press all the parts producing or regulating the impression—such as the platen, the tympan, and the frisket—were flat, so that the pressure was applied to the whole of the type at once; whereas in the new press they were converted into an impression *cylinder* and the pressure, consequently, applied to the type successively, so that line after line became printed as the cylinder revolved, with the sheet attached to it, over the form.

The consequence of such an arrangement, simplifying as it did the parts of the old form of press, was that the *nine* distinct operations, which we have before stated had to be gone through by the hand-press man in order to produce each impression, came to be correspondingly reduced, and the process of printing therefore proportionately accelerated.

1. The inking of the rollers, and the subsequent inking of the type, were rendered in the machine by one operation, for they were performed at one and the same time with the mere traversing of the type table.

2. While the laying on of the sheet had still to be executed by hand, the after process of flying the frisket and folding it down on the tympan, and then the two together on the form, were necessarily got rid of altogether.

3. The running in of the type table, taking the impression, and then running out the table in return, were no

longer three distinct operations, but all united in one, owing to the pressure being applied *during* the motion of the table itself.

4. For this reason, the lifting of the tympan and frisket was also superseded.

5. As the laying on of the sheet necessarily formed a part of both hand and machine-printing, so did the taking off of the sheet and placing it on the bank.

In this way the nine operations necessary in hand-printing were reduced to four, or virtually to three—since the inking went on at the same time as the table was being run in and out. These three operations were,—

1. Laying on the sheet.
2. Running the table in and out, or giving the impression.
3. Taking off the sheet.

Hence it will be readily understood how, even with Koenig's defective machine, the impressions could be

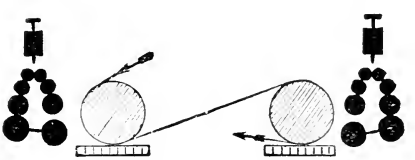

Fig. 4.—Koenig's Double Cylinder for both Sides of Sheet.

thrown off at the rate of more than 1,000 per hour, or four times as quickly as they could by an ordinary pressman.

It forms no part of our design, as already stated, to attempt a chronology of the improvements in printing machinery, or to award to any one the credit of effecting any particular improvement. Hence, after endeavouring to show the principle of cylinder machines, and why their working superseded the previous hand presses, we shall at a bound pass over the developments of more than half a century, and describe the mechanism of the printing machines of the present day.

CHAPTER IV.

APPLEGATH AND COWPER AND THE FIRST BOOKWORK MACHINE.

IN 1816, Edward Cowper curved stereotyped plates, and fixed them on cylinders for printing long or continuous sheets of paper; such machinery was used for fifty years for printing labels in two colours, and for printing 4,000,000 of £1 bank-notes at the Bank of England; these were afterwards destroyed when £1 bank-notes were abandoned.

In 1818, Edward Cowper invented several important improvements in printing machinery. Firstly, a flat distributing table, on which the ink was uniformly distributed by distributing rollers having an end motion as well as rotary motion, and inking rollers having a simple rotary

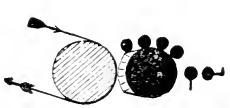

Fig. 5.—Cowper's Single Cylinder for Curved Stereotype.

motion. The end movement of the distributing rollers was produced by inclines on the edges of the table, acting on rollers on the "waving frame" carrying the rollers. The ink was supplied to the table in very small quantities, at intervals, by a roller which vibrated between a metal roller supplied with ink (and having a metal straight edge to remove any surplus) and the distributing table, to which the small quantity of ink was communicated each time that the vibrating roller touched it. Secondly, the use of continuous double tapes or strings, and conveying drums, to carry the paper from the first printing cylinder to the second, to be

printed on the opposite side, thus securing the paper from shifting or creasing. Thirdly, a feeding apparatus, consisting of a web or series of wide tapes connected to a drum, having intermittent motion, properly timed, to carry forward the sheet of paper laid by the boy on the surface of the web, there being two small wood projections on the web to insure the sheet going forward. This machine worked ordinary flat forms, which ran to and fro with the distributing tables, and are commonly called "perfecting machines," from their printing both sides.

This patent is also memorable for the first suggestion of the hand-inking roller, made with a composition first used for printing by Donkin & Bacon in 1813, and the distributing table, since universally used for hand-presses. Up to this time, the types had been coated with ink by means of pelt "balls," involving much labour to the pressman.

In 1823, Mr. Augustus Applegath conceived and patented the ingenious idea of placing the distributing rollers at an angle across the distributing table, so that they might run endways of themselves. This was a simplification, and it was at once adopted by the firm of Applegath & Cowper. Many two-cylinder machines were made for country newspapers, one cylinder printing when the form went one way, and the other cylinder printing when the form went the other way.

There are two modifications of the perfecting machine—the Web machine and the Drop-bar machine; which are distinguished by the contrivance employed for receiving the sheet.

In the Web machine, the paper is fed in by means of a web, or series of wide tapes, which lie upon the laying-on board. A small drum stands directly under the board, and to it the tapes are fastened. On the off-side of the spindle is a series of cogs, resembling somewhat a quarter of a toothed wheel, or a sector, with a long wooden arm fastened to the under side. A stud is fixed on the cylinder wheel of the inner form, and when it comes into a certain position the stud strikes the arm, bringing the cogs on the drum into gear with a similar set on the cylinder wheel. By this motion the drum is forced back half its diameter, and moves the web, or tapes, in the same direction. The sheet, having

been laid to a back mark on the tapes, is propelled between two revolving rollers, and is thus taken into the machine. In the Drop-bar feeding arrangement, which is also to be found in machines constructed on Cowper's plan, and has already been mentioned, there is a revolving steel bar, on which are fastened two discs, or bosses, about half an inch thicker than the bar. The bar is fixed immediately above the receiving drum of the ordinary perfecting machine. The discs can, by means of screws, be shifted to any position along the rod, so as to suit the sheet to be printed. The revolving motion is communicated by the tapes which pass round it. To the rod is fixed a short arm, which has a tumbler at the end. This tumbler travels round a wheel with a dip, which causes the drop-bar to fall upon the paper, laid to a front mark on the receiving drum. By this means the sheet is run into the machine.

In other respects the web and drop-bar arrangements are exactly the same. A driving or lay shaft is placed at the back or off side of the machine, and extends from outside of the machine, on which are placed the fast and loose pulleys or drums, to the centre underneath, whence, by bevil gear and an upright spindle, the tables and coffins are worked. The rack is fixed on the under side of the table, and is supported at each end by bars or slides, sufficient room being allowed for it to move from one side to the other, driven from the upright spindle by a pinion.

The rack is controlled by the "parallel motion," which is bolted underneath the coffins at one end, and to the rack at the other, a cross-bar connecting the two. The tables are supported by a set of pulleys on each side of the machine, those directly under the cylinders being larger than the others, in order to bear the strain of the impression. A very important detail is to be noticed in the large or impression cylinders. The surfaces of these are of two different thicknesses, the part that travels inwards to give the impression being thicker than the other portion, so that when the form returns, it passes underneath the smaller surfaced part of the cylinder.

As soon as Mr. Cowper's machine had been fairly proved, Mr. Walter, of the *Times*, wished him to improve

the machine that had been made by Kœnig, and this was done, the inking apparatus being taken away and Cowper's apparatus being substituted, and numbers of wheels being dispensed with. Later on, Applegath & Cowper made a four-cylinder machine for the *Times*, which printed 5,000 per hour, two alternative cylinders printing one way, and the other two the other way.

CHAPTER V.

CLASSIFICATION OF PRINTING MACHINES.

PRINTING Machines may be classified as follows :—

1. Platen machines, in which the paper is brought down as a flat sheet on a mass of flat-laid type.

2. Cylinder machines, in which the paper is wound on a cylinder and pressed upon flat-laid type by the revolution of that cylinder.

3. Rotary machines, in which the type, or rather a stereo cast of the type, is itself placed on the periphery of a cylinder and with it revolves in contact with the paper, which is supplied as a web.

Belonging to Class I. are large single and double book-work platen machines, with a horizontal platen and horizontal

Fig. 6.
Platen.

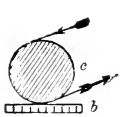

Fig. 7.
Single Cylinder.

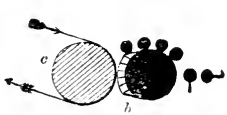

Fig. 8.
Rotary.

type form ; and treadle platen machines, which have an almost vertical platen and type form, also vertical at the instant of receiving the pressure.

Belonging to Class II. are double or perfecting machines, and two-colour machines, and single cylinder machines, which may have more than one feeding apparatus.

Belonging to Class III. are all machines in which the reciprocating type bed is superseded by cylinders bearing the form and the paper respectively.

We may now consider the several parts of which all of these machines are composed.

These parts may be reduced to *four*, viz :—

1. The feeding appliances.
2. The inking apparatus.
3. The impression arrangement.
4. The delivery apparatus.

THE FEEDING APPLIANCES.

It may be convenient to describe, first of all, the feeding arrangements of an ordinary *cylinder* machine.

The feeding apparatus is composed of two separate and distinct parts : (1) that for *laying-on* the sheets, and (2) that for *gripping* or taking them.

In the hand-press the workman, in laying a sheet on the tympan, makes use of "points" fastened to the sides of the tympan frame and extending some few inches towards the middle of it, with the view of securing "good register," that is, that each page, and indeed every line in it, shall fall exactly upon that part of the one side of the paper which is immediately at the back of every line in the next page, printed on the other side of it. The two iron points puncture small holes in the sheet during the printing of the first side. When, therefore, the "reiteration" comes to be worked,—that is, when the second or backing form is laid upon the press,—the sheet is placed upon the points so that they exactly pass through the holes produced during the first impression, and the consequence is, the impression at the front and that at the back are made exactly to correspond, owing to the points falling into the holes previously made.

The early printing machines were fitted with no appliances corresponding to this pointing apparatus. Indeed, the feeding apparatus was so defective, that fine work, especially in regard to register, could not be accomplished by them.

The feeding board, at first, consisted of merely a board like a desk, attached to the upper part of the machine, on which the white paper was placed. Sheet after sheet was "stroked" forward to the front of the board so as to be

carried by the web connected with it towards the tapes which passed round the impression cylinder. A sector passed the sheet into the tapes, which subsequently conveyed it round the cylinder.

The front lay.—To insure accuracy in laying on, a series of lines was drawn on pieces of card or stout paper, and these were pasted on to the front edge of the laying-on or feeding board. This was called the "front lay."

The back lay.—Another plan for obtaining accuracy in laying-on was to drive pins into the back part of the board, these pins being used as guides to the back edge of the paper. This was termed the back lay.

Both of these methods were attended with great defects. The front lay was the more imperfect of the two. The accuracy of the lay by such means would often vary in proportion to the thickness of the line; and this, even as small as the difference may seem, served to throw the margin out considerably. Moreover, the time required for laying the sheet exactly along the line necessarily caused the machine to be driven at a slower speed. It was considered very good work to lay to a line accurately at the rate of 1,000 per hour; whereas, with the present improved appliances for attaining the same end mechanically, as many as 1,800 sheets can be laid with extreme accuracy in the same time.

On the other hand, by the pin system of laying to the back edge of the sheet, all the inequalities in the sides of the paper were thrown to the front edge of it. The consequence was that the apparatus for taking the sheet very often missed, owing to some sheets being cut at the mill or in the warehouse narrower than others.

The first really useful jobbing cylinder machine was that invented by Thomas Main, a practical machine-minder. It has to a certain extent been the model of all subsequent machines of its class, and we may now proceed to show why this has been so. In Main's machine the defects above mentioned were not only remedied, but greater speed and certainty in the process of feeding were obtained. Movable stops or marks attached to the front edge of the feeding board were applied, and, by means of these, sheets could be laid on with accuracy, almost in the dark. More

than this, so extremely perfect was the lay thus produced, that for ordinary printing the pointing apparatus might be wholly dispensed with. Moreover, the laying-on boy could bring the front edge of each sheet up to the marks or stops without waiting to observe whether the edge of the paper was in its proper place, and was consequently enabled (since he could tell by his mere touch whether the sheet was accurately laid) to feed the sheets with nearly double the quickness.

This improved method of laying on the sheet was effected in the following manner. Under the narrow plate of zinc which is let into the face of the board, so as to project slightly over the front edge of it, is a bar mounted in bearings; and on this bar is fixed a series of marks or lays, at distances which admit of being adjusted to the various sizes of the sheets to be printed. These marks consist of rectangular pieces of thin steel, and the upright ends of them are made to project about half an inch above the face of the zinc plate, and about one inch from the front edge of it. Thus, when a sheet of paper is laid on the feed board, they act as stops, and prevent it being driven any further forward. At the end of the shaft or bar on which these stops or marks are arranged, there is a "tappet" or short lever which has a "slot" cut at the lower end of it, the tappet, the bar, and the marks all being connected with the under part of the feeding-board, and moving backward and forward with it. Then, fixed to the machine frame, is a steel stud, which works in the slot of the tappet; so that, as the feeding board approaches the impression cylinder, for the purpose of feeding the sheet, the tappet is acted upon by the steel stud, and thus the bar is caused to turn on its bearings in such a manner that the stops or marks arranged along it are made to dip, and the edge of the sheet is consequently left free to be taken by the gripper of the impression cylinder. This means of insuring accuracy of lay is found to be so efficient, that the sheet can be fed with nearly double the quickness and nicety to which it can by any other method; and indeed, owing to the vertical stops projecting slightly above the face of the board, the white paper can, as already mentioned, almost be laid on in the dark.

To insure greater accuracy of lay, however, and consequently more perfect register, a method of mechanically pointing the sheets has been introduced. This is generally effected by means of two long flat bars, each having a "slot" (or slit) at one end and a point at the other. These bars are fixed to the underneath side of the feed board, so that the points project upwards, just above the face of the board, through suitable gratings provided for the purpose, the points being depressed in the same manner as the movable guides or stops in the front lay apparatus. The points, in short, were vertical, and automatically depressed in a frame-work. But, by this method, owing to the point bars being made to work on a fulcrum, and thus to have a radial action, the sheet is apt to shift between the time of the points leaving the paper and its being "taken on" to the impression cylinder, for, in consequence of a radial action of the bars, the points are not vertically depressed, so that the fine holes made by them in the paper necessarily become somewhat enlarged during the decline of the point bar; and by such means the accuracy of register, which they were intended to insure, is in a measure destroyed.

An improved method of pointing was introduced by Mr. William Conisbee, about twenty years ago, which entirely obviated the defects of the radial action. By its means the most accurate register could be obtained, even when many colours have to be printed at a single cylinder machine through which the sheet has to be passed as many times as there are different colours to be printed.

There is a metal frame, of the size of the largest sheet which the machine is intended to print, fixed to the underneath side of the feed board, and working vertically on guides, and depressed by inclines. This frame is provided with any number of points desired, and these admit of being adjusted, by means of suitable slots in the flat bars to which the points are attached, in any required position, so that a sheet may be pointed by such means, either at each corner or in the middle, as well as in the length or breadth of the paper. The feeding board has apertures covered with brass gratings, through which the points slightly project. The point frame is held in contact

with the under side of the feed board by means of four coiled springs, one of them being placed at the guides at each corner, thus serving to keep the frame in position. The sheet to be pointed is laid on the feed board and the points passed through it in the usual manner, and, on the advance of the board to the impression cylinder, the metal frame is depressed vertically, carrying the points straight down with it, without the possibility of any radial action. This occurs at the very instant when the grippers are in a position to take the sheet. The principle is that the points are depressed vertically rather than radially, and, at the very instant when the sheet is being seized by the grippers, it becomes impossible for the laying-on boy to shift the paper from its place before it is taken to the cylinder. Nor is the hole in the least enlarged by such means; so that, on printing the second side, the sheet can be fixed so exactly in the place it occupied at the time of printing the first side, that the most accurate register is insured. Indeed, by this means, a sheet can be passed through the machine, over the same form, as many as six or more times without any perceptible difference in the thickness of the lines of the letters or slur in the print—except, indeed, such as may arise from the enlargement of the holes in the paper, owing to the points being passed so repeatedly through them.

In the earlier printing machines the taking-on apparatus consisted of a web and tapes, the web being composed of a series of linen girths, passing across the surface of the feeder and extending to a roller at either end of it; so that, when these rollers were partially turned round, the motions of the girths carried the sheet forward to a smoothing roller, and there delivered it over a wooden cylinder which was called the "entering drum." By means of a small quadrant attached to the axis of the feeder, the sheets laid upon the girths were made to move at regular intervals, the quadrant serving to carry them successively into the machine at the right moment, as well as to prevent them occupying a wrong position, or interfering with the sheet which was in the course of receiving the impression. By such means the feeder was made to deliver the sheet of white paper to the entering drum, and it was there seized by two systems of

endless tapes. The tapes were passed over a series of small rollers to keep them extended, and remained in contact with both sides of the sheet during its entire passage through the machine; for they were so arranged as to fall between the pages of the printing and on the margins or edges of the paper. In this way the sheet was conveyed round the impression cylinder and ultimately delivered, duly printed, on to the taking-off board. This method of taking-on sheets is still in use in some of the older forms of machines.

With the present fast perfecting machines, however, it

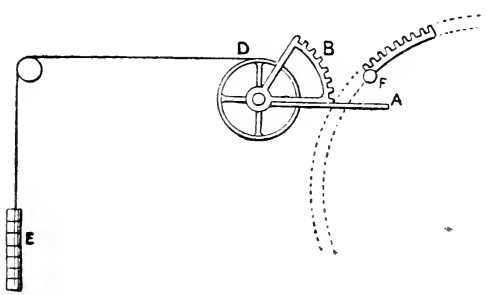

Fig. 9.—"Web" Laying-on Motion—Perfecting Machine.

A, Wooden arm.
B, Sector.
D, Wheel on end of web-drum.
E, Weight.
F, Pin on cylinder wheel.

The inner-form cylinder wheel is indicated by the dotted lines.

would be impossible to lay on the sheets with the old "web and tapes," with sufficient rapidity, and, therefore, an apparatus called the "drop bar" has been introduced. This drop bar is fitted with "bosses," and admits of being depressed by means of a cam of peculiar shape, so that, when the sheets have been stroked down to a mark on the feeding board, it falls down on the front edge of the foremost one; while the bosses, owing to their having a continuous revolution serve to drive the sheet forward at the proper moment between the tapes, and thus it is carried round the im-

pression cylinder as before described. Drop bars are attached to most of the ordinary fast perfecting machines.

GRIPPERS.

There are also other means of taking on the sheet in connexion with printing machines; these consist of "grippers" rather than webs or drop bars—the latter serving only to carry the sheet instead of gripping it on the impression cylinder. Such grippers are fitted on to the front, or into the inside, of the impression cylinder itself, part of the surface of which is cut away in order to admit of the working of the gripper-bar upon bearings fixed within it.

There are three kinds of grippers used for this purpose :—

1. The tumbler gripper.
2. The spring gripper.
3. The continuous gripper.

The tumbler gripper is generally connected with the single cylinder perfecting machines, such as the Napier and "Desideratum," and is made to act as follows :—

At one end of the shaft which carries the tumbler gripper, and which projects slightly beyond the extremity of the impression cylinder, is fitted a small pinion, gearing into a segmental wheel; this wheel works on a stud attached to the same frame as that which carries the gripper bar. In the face of the segmental wheel there is a steel tumbler roller which works on a pin, the whole of the apparatus forming a part of the impression cylinder itself, and rotating with it. Now, as the cylinder rotates, the tumbler roller passes through a "shape," or in other words, a peculiarly-shaped groove, fixed to the main cylinder of the machine; by this means the tumbler roller is thrown over, and the bar carrying the gripper with it; so that the grippers, which are merely long brass claws attached at intervals to the bar, are made to seize the end of the sheet projecting over the feeding board, and, as they fall upon the edge of the aperture in the surface of the impression cylinder, to hold it firmly there, and thus to carry it over the form on the impression table below. As the cylinder continues to rotate, the tumbler roller at the extremity of it passes through a like kind of shape, which reverses the action of the gripper, for the purpose of releasing the sheet,

and of allowing it to be delivered on the taking-off board at the moment required. The defect of this method of taking on the sheet consists in what is called the "double beat," or slight rebound, which this form of gripper invariably gives, in the act of closing upon the aperture in the impression cylinder, owing to the suddenness with which the gripper is thrown over in order to seize the sheet. The consequence is, that accuracy of the lay is apt to be interfered with during this rebound of the gripper, and imperfect register, therefore, is often the result.

TREADLE PLATEN MACHINES.

The arrangements of the treadle platen machine necessitate a different kind of feed to those already described. The form is fixed to the bed of the machine in a perpendicular position. The boy lays the sheet on the platen, and the treadle, in conjunction with knuckle joints, brings the platen up to the form, when it receives the impression. The motion is, therefore, as follows :—

1. The platen is opened.
2. The sheet is fed to lays and adjusted, in order to secure register.
3. The impression is taken.
4. The platen is reopened.
5. The sheet is removed by the hand of the operator.
6. With the other hand the next or "white" sheet is fed in.

The time available for feeding is, therefore, comparatively limited; hence we find that about 1,000 per hour is the average speed of a treadle platen machine.

In 1884, Mr. Godfrey, a Manchester engineer, invented a "Gripper Treadle Machine," which is undoubtedly very ingenious. He introduced the following new features :—

1. A stationary feed board.
2. Self-registering lays.
3. Rotary grippers to secure the sheet on the platen.
4. A self-delivering motion.

The paper is placed roughly on the feeding board, and the side and bottom lays bring it into its exact position automatically. The gripper then advances and removes the sheet from the feeding board to its exact position on

the platen. The impression is then taken, the platen goes back, and the sheet is taken from the board by another set of grippers, and at the same time the first sheet is delivered on the delivery board. There is no taking-off arrangement, but the same gripper that feeds the sheet delivers it on to the delivery board. There are four distinct grippers revolving round the centre of the platen. In this way a speed of 3,000 per hour can be gained. A totally inexperienced person can feed this machine, as the paper has simply to be placed on the board, and the lays will automatically move the sheet into its exact position. The platen can be turned up and made to assume a horizontal position for convenience of working.

ROTARY MACHINES.

The previously-described arrangements are for feeding in *separate* sheets. In the rotary machine, however, a web of paper is used, and before or after printing it is cut up into separate sheets. The Walter Press may be taken as the type of this machine, and to it the following particulars apply. At one end of the machine is a continuous roll of paper wound upon a spindle. Each roll of paper used is about 8,000 yards in length (more than four miles), and weighs 800 lb. The paper is passed from the roll over a tension roller, and then over damping cylinders, by which means it becomes thoroughly wetted on both sides. It then passes over other rollers, which serve to complete the saturation of the paper by pressing the water into it as it bears against the surface of the rollers. The damping is performed thus. The cylinders are hollow, and are perforated all over with small holes, and are supplied with steam by means of a small pipe. The steam condenses on the blankets through the perforations on the cylinder. After having been thus rendered thoroughly damp, the paper passes between two small rollers, and is thus squeezed. It then goes to the printing appliances.

WEB PLATEN MACHINES

have been devised for job work; but they have never been adopted to any considerable extent. The reason of this is

that they necessitate the keeping in stock of a variety of webs of paper—a variety indeed which no ordinary printer could possibly hope to have constantly in his warehouse. It is obvious that it would not be possible to keep rolls of every size and quality in use. Again, through the time involved in adjusting the machine, its advantages, with regard to space, would be much minimised.

At the Inventions Exhibition of 1885 a machine of this kind, invented by Mr. W. C. Kritch, was shown by Messrs. Greenwood & Batley, of Leeds. It was said to print from the reel at the rate of 3,000 per hour.

CHAPTER VI.

INKING APPARATUS.

THE inking apparatus common to nearly all printing machines is due principally to the late Professor Cowper, who, in the year 1818, patented a perfecting machine, which was nearly the same as that now known as the Applegath-and-Cowper Machine. In this patent the plan of distributing the ink upon a flat table was first introduced; and the combination of the inking table and inking rollers now in general use also formed part of the specification. The distributing rollers, however, are due to Mr. Applegath, who, in 1823, obtained a patent for effecting this object by simply placing the rollers diagonally across the inking table instead of at right angles to its motion. The inking apparatus remains to this day almost the same as devised by these two gentlemen.

It consisted of a trough called the "ink-duct," or, vulgarly, the "ductor," at the bottom of which is a knife, which is adjusted to the periphery of the accurately-turned iron roller supplying the ink, and is mounted on a cast-iron plate, fitted with screws along the back of it. These screws are for the purpose of narrowing and widening the aperture between the edge of the knife and the iron roller, and thus allowing a thinner or thicker film of the ink, which is laid along the duct or trough formed by the junction of the roller and the knife, to be taken up by an iron roller called the inking cylinder as it is made to rotate by means of the ductor bands passed round a grooved wheel fixed to the end of its axis which is the shaft. Immediately underneath the ink-duct is placed a vibrating roller, covered with the ordinary composition used for printers' rollers, and set in vibratory arms worked by a small cam which is attached to

one of the large wheels of the machine. This is for the purpose of taking the ink, as the roller vibrates up and down, from the ductor, and depositing it on the ink-table in the course of its transit backward and forward; for the ink-table is made to form part of the type-table of the machine. The ink thus deposited by the vibrating roller is distributed evenly over the entire surface of the inking table by means of other rollers placed diagonally across the frame of the machine. These are called the distributing rollers and the spindles of them are made so long that they lie in notched bearings rather than fixed ones, which are raised slightly above the table of the machine. These are

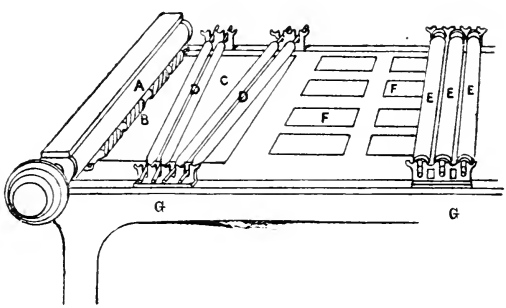

Fig. 10.—Inking Arrangements :
A, Ductor-roller; B, Vibrator; C, Ink-table; D, Wavers or Distributors; E, Inking-rollers; F, Form; G, Roller Forks.

called the "roller forks." As the ink-table moves to and fro under the distributing rollers, they not only rotate, but have a motion in the direction of their length, in consequence of their oblique position; and this compound movement produces perfect distribution of the ink. They are called "wavers."

At some slight distance from the distributing rollers are placed the inking rollers for transferring the distributed ink from the surface of the ink-table to that of the type. These also rotate in roller forks, so as to allow them to move up and down, and thus bear with their weight, not

only upon the inking table but upon the forms as they pass successively under them. By this means the ink, after having been distributed by the diagonal rollers, is taken up by the inking rollers during the reciprocating movement of the impression-table in their passage over the inking table, and given off by them to the type in the course of the traverse of the form beneath them. Hence it follows that

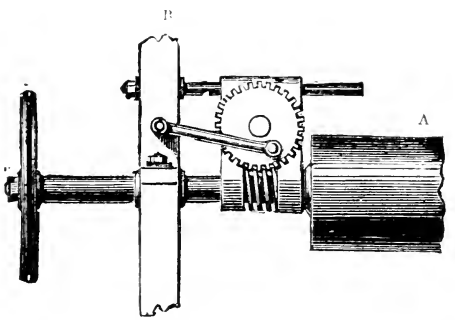

Fig. 11.—A, Ink-drum; B, Frame of Machine.

every time the type passes to and fro the form receives twice as many distinct inkings as there are inking rollers attached to the machine, *i.e.*, two from each of the inkers,—there being the same arrangement of distributing rollers and inking rollers, ductor and vibrating roller, at either end of the machine.

In the Napier platen machine there is used for the same purpose as "wavers" an ink-drum, having a motion from side to side, imparted by the mechanism shown in fig. 11, and described on p. 68.

The inking arrangements of treadle platen machines will be noticed elsewhere.

CHAPTER VII.

IMPRESSION ARRANGEMENTS.

THE varieties of printing machines, which are very numerous, have been already classified according to the nature of the impression apparatus. There are four different kinds :—

1. The continuously-rotative cylinder as seen in Web-printing machines.

2. The intermittently-rotative cylinder, or stop-cylinder, as seen in the Bremner, Wharfdale, &c., machines.

3. The semi-rotative, or tumbler, or "rocking" cylinder.

4. The impression plate of the platen machine.

In ordinary cylinder or perfecting machines the form of type is placed on a flat surface, and in such cases it is essential either that the cylinder should travel over the type, as in the obsolete "Belper" and "Ulverstonion," or that the type-table should have a reciprocating motion. In the continuously-rotative web-printing machines the type or curved stereo-plate is fixed on the surface of cylinders or drums, and made to rotate, either vertically, as in the original *Times* Applegath machines, now obsolete, but from which the whole of the *Rotaries* have undoubtedly sprung; or horizontally, as in the present Walter, Hoe, Victory, Prestonian, &c.

The principle of the single-sheet Hoe machine, which preceded the Walter press at the *Times* Office, consisted of one central cylinder carrying the forms and inking surface, while a series of impression-cylinders, covered with blanket and each with its inking rollers adjoining it, were made to surround the central drum at different points, these cylinders being all geared to the central one and moving in unison therewith. Such a machine had so many feeding boards connected with it as there were impression-cylinders, and the sheets, after being printed, were carried by means of tapes and deposited by special mechanism, called "flyers," in a pile on the delivery-board. The old "Desideratum" machine, however, had a continuously revolving large cylinder, but while obsolete in this country, it is largely adopted in America, as in the "Campbell Press."

In single-cylinder and perfecting machines the type is placed on a table or flat surface. The form reciprocates with the table on which it is laid, instead of revolving continuously in one direction with the drum on which it is fixed. In single-cylinder rotative machines the impression-cylinder is made so that the part of its periphery which comes in contact with the form, in order to give the impression, shall have a larger radius than the remaining portion of the

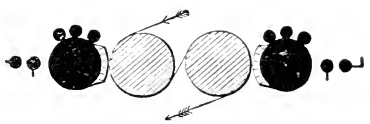

Fig. 12.—Cowper's Double Cylinder for both Sides of Sheet.

cylinder, since by such means the form is enabled to return with the reciprocating motion of the table without being injured by contact with the cylinder. It will thus be seen that the circumference of the impression-cylinder must be exactly equal to the backward and forward traverse of the table.

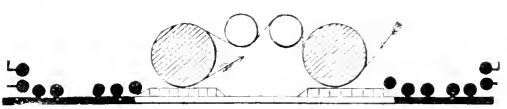

Fig. 13.—Applegath & Cowper's Double Machine.

In other machines, such as two and four-feeders, the impression-cylinders are lifted, by means of cams or other suitable appliances, at the time of the table returning after the impression has been taken, in order to admit of the passage of the type beneath them, except in single-cylinder two-feeders, which print both ways, having a tumbling cylinder, which continues to rotate backwards and forwards with the table.

In the stop-cylinder machine, also, the impression-cylinder is geared directly to the table; but it has a portion of the teeth of the fixed cylinder-wheel cut away, so that as the table returns the impression-cylinder itself remains unacted upon by the rack on the table. The same end is attained in other machines by means of a loose wheel working on

the cylinder-shaft, the cylinder being kept in a stationary position, during the return of the table, by means of a break or stop acting upon it.

In the semi-rotative cylinder machine the cylinder has none of the teeth cut away, nor is that part of it which

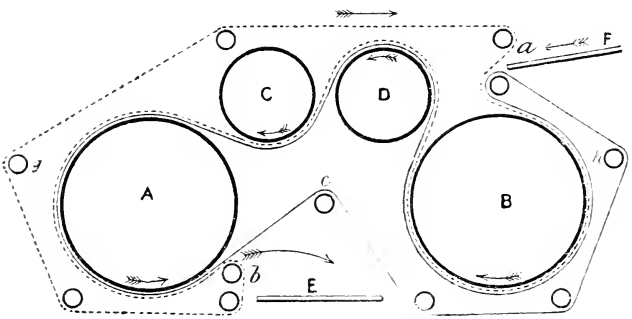

Fig. 14.—Travel of Sheet.

comes into contact with the form, in order to give the impression, made of a larger radius than the remaining portion ; but the cylinder has to be lifted at the time of the table returning. On the contrary, the fixed wheels on the cylinder gear directly into the racks at each side of the type-table, and a peculiar cradle or rocking motion is given to the cylinder by means of spur-gear, traverse wheels, and racks which act upon cranks and connecting-rods below.

In the platen machine *for bookwork*, the impression is given vertically, rather than cylindrically, by means of a flat plate instead of a cylinder, the platen being lifted by means of a crank and connecting-rod attached to the end of a beam. The type-table has an intermittent reciprocating motion, and there is a tympan and frisket attached to this as in the hand-press, the same system of pointing being used, and the tympan and frisket being opened partly by the mechanism of the machine and partly by the taking-off boy in attendance upon it. These platen machines are necessarily much slower than those fitted with cylinders ; indeed, only from 600 to 700 impressions can be printed from them in the course of an hour.

The general principle of *perfecting cylinder machines* is that there are two impression-cylinders and two distinct type-tables, so that the two forms can be laid on at one and the same time, one at either end, and both sides of the sheet printed during one passage of the tables. In the ordinary construction, invented by Cowper & Applegath, the sheet to be printed is fed from the top of the first of the impression-cylinders, and is then carried, by means of tapes or grippers, under the first cylinder and over the first of the two drums which are placed between the cylinders in order to reverse the sheet as it travels from one cylinder to the other. It next passes under the second drum and on to the

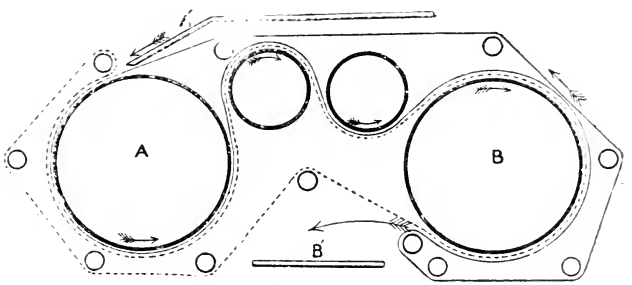

Fig. 15.— Overhead Feeding.

A', Laying-on board. A, Outer-form cylinder.
B', Taking-off board. B, Inner-form cylinder.

second cylinder, where it receives the second impression, and is then delivered upon a taking-off board, situate at the bottom part of the machine between the two cylinders—the tables in such perfecting machines having a reciprocating motion while the impressions are taken, the cylinders continuing to rotate.

This form of machine was first patented by Applegath & Cowper in 1818. It was an extensive modification of one previously invented by Koenig for the *Times*, its principal improvement consisting in the two drums between the impression cylinders. It had reciprocating tables, the cylinders continuously rotating, and lifting alternately, than is to say, rising and falling.

In 1828 David Napier made several alterations in the perfecting machines then made by Applegath & Cowper. It was he who invented the appliance already described as "tumbler grippers." These took hold of the sheet from the feed-board, retained it while receiving the first impression, and released it at the moment when the corresponding apparatus in the other cylinder printed the second side or "reiteration." The grippers were contained within the cylinder. When the white paper impression-cylinder arrived at the proper position, the upper limb of each pair of grippers having been opened to release the former sheet, the attendant laid another sheet to the gauge, when the grippers closed on the edge of the paper, the sheet was wrapped round the periphery of the cylinder, and there retained whilst it received the impression on one side, after which, and upon the arrival of the cylinders, or rather the grippers contained in the cylinders, at the proper position, the grippers contained in the second cylinder took hold of the sheet close by the others, whilst they, at the same time, released their hold, and the sheet was in like manner conveyed round the second cylinder to be perfected. The instant this was effected the grippers again let go their hold, and the sheet, printed on both sides, was discharged from the machine to the receiving-board by the action of tapes or cords, so that one sheet was going into the machine and another coming out at the same time.

This machine was distinguished by great compactness, owing to an arrangement for causing the cylinders to rise and fall intermittently, which enabled them to perfect without the intervention of the drums, as in the Applegath & Cowper machine. As soon as the first cylinder gave its impression it rose up, so as to avoid coming into contact with either of the forms until it was again its turn to print, while at the same instant the second cylinder descended for the purpose of giving the second impression. Thus the cylinders were alternately rising and falling during the whole process of working.

This machine was subsequently greatly improved in France, and became appropriately known as the Anglo-French Machine. The improvements, however, relate to parts which are referred to in other chapters.

CHAPTER VIII.

IMPRESSION ARRANGEMENTS OF ROTARY MACHINES.

THE impression arrangements of rotary machines now require notice. Nicholson, as already mentioned, devised an apparatus on the model of the calico-printing machine, but never carried his scheme into effect. Koenig's machines were, first, a modification of the handpress, 1804; then a screw platen machine, 1810; then a single cylinder with a reciprocating bed, 1811; afterwards a two-feeder single cylinder, 1814; and a perfecting machine, 1814. The first machine that can be classed as a "rotary" was Bacon & Donkin's of 1813.

The inventor, Mr. Richard M. Bacon, of Norwich, was a printer, and, being anxious for some more speedy means of producing his journal, the *Norwich Mercury*, associated himself with a mechanician, Bryan Donkin, of Bermondsey. They designed a machine in which the types were arranged in a prismatic form on an axle, the impression being made by a revolving cylinder. The ink was applied by one roller, which rose and fell with the irregularities of the prism. The sheet of paper was wrapped on another prism, so formed as to meet the irregularities of the prism. One of these machines was erected at Cambridge University. The chief fault was the inadequacy of the inking arrangements.

Bacon & Donkin's invention was quite novel, and certainly most ingenious. The principle of the four-sided prism, however, has been entirely abandoned in favour of the cylinder. About 1870, Mr. George Newsum, of Leeds, designed a machine which bore some relation to it. It was a "rotary two colour machine," and consisted of two cylinders working together, the smaller of which made two revolutions to one of the larger. The latter was cut so as to

have *two flat beds* equidistant from each other, the remaining surface being curvilinear and serving as ink-tables. When the type-beds or flat surfaces faced the impression cylinder, the latter moved forward to give the impression. The inking arrangements (with which we are not now concerned) were such, that when one inking surface was uppermost, only the proper coloured rollers were allowed to touch, and in this way each form was inked only by its proper rollers. This machine has not, we believe, come into use.

For several years Mr. W. C. Kritch, an engineer in the employ of Messrs. Greenwood & Batley, of Leeds, has been engaged in designing a "continuous web platen press." The type, or rather stereotype, is placed on the four sides of a revolving prism, somewhat as in Bacon & Donkin's machine. The paper is fed from the web

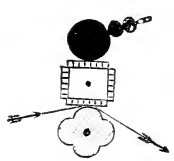

Fig. 16.—Bacon & Donkin's Rotating Prism Arrangement.

automatically cut into sheets, printed, and delivered in piles. The speed is said to be 3,000 per hour. A machine of this kind was exhibited at the Inventions Exhibition, London, 1885.

We must now return to the practical improvements displayed in the machines that immediately succeeded Bacon & Donkin's. The first place must be given to Mr. Edward Cowper, who in 1816 took out a patent entitled "a method of printing paper for paper-hangings and other purposes." The cylinder revolved under inking rollers. It was covered with the form, in the shape of stereo-plates, and these were curved to suit the periphery. The type was moulded in plaster of Paris, and a flat plate cast in the usual way. This was then heated and laid on some soft substance on a level bed, face downwards. The two were then passed

through cylinders, the degree of pressure employed producing the curve required. The curved plates were, as stated, afterwards placed on the cylinder. The inking rollers, first of all, distributed the ink on a part of the cylinder, and then inked the plates. There was a large ink-supplying and distributing roller fed by a vibrator. Curved plates, bent after being cast, were many years afterwards successfully adopted in Pardoe's "Whitefriars Machine."

In 1835 Mr. (afterwards Sir) Rowland Hill patented "certain improvements in certain methods of letterpress printing by machinery." A machine was built on this patent in the following year by Messrs. Dryden & Co., of Lambeth. The types were tapered, the inking arrangements almost similar to those of Cowper & Applegath, and the paper was printed in continuous rolls. Cylinders revolving continuously cut up the paper into sheets. A perfecting machine was described in the specification.

Two years afterwards (1837) David Napier invented the type-revolving machine which was perfected twenty years after by Hoe, in the form of the Lightning Press. The origin of the latter has hitherto been incorrectly ascribed to Hoe. Part of the type cylinder (stereotype) was utilised as a distributing surface for the ink, and the number of pressing cylinders could therefore be increased. A vibrating feeder-roller took the ink in the ordinary way from a duct roller, and communicated in two or three revolutions to the distributing surface, so that each set of inking rollers passed over the whole length of the distributing surface before they came into contact with the type, there being one set of inking rollers for each impressing cylinder.

One of the principal impediments to speed in the single-cylinder and flat-bed printing machines was owing to the reciprocating motion given to the impression table, which carried the type as well as the inking table with it. This great weight had to be moved backwards and forwards at a high rate of speed, and the momentum of the heavy table had not only to be neutralised at each change of the motion, but the inertia of the dead weight also overcome, in order to start the table in the opposite direction; or, in other words, two dead stops occurred, and two fresh impetuses had

to be given for each revolution of the cylinder. This no only occasioned a great waste of motive power, but rendered the machine liable to breakages and serious accid ents.

It was found, moreover, at the *Times* office, where the highest achievement in printing engineering was then employed, that, with sheets of such magnitude as were necessary for that journal, each layer-on could not feed them at a more rapid rate than twenty-five per minute, which wa equal to 1,500 sheets an hour; so that, with four impressio n cylinders and four feeding tables, it followed that the machine could be fed with only 6,000 sheets in the course of each hour. It was, however, requisite to construct a machine which should throw off at least 10,000 copies an hour, and this would require as many as seven cylinders to compass. The arrangement of these in one machine presented mechanical difficulties of a very formidable kind. Applegath, therefore, determined to abandon the reciprocating motion of the type-table, and to proceed to the construction of a machine in which the type was to be placed on the surface of a cylinder, after Nicholson's old plan. The cylinder was to rotate on a vertical axis, with a continuous rotary motion.

This machine was fitted with eight impression cylinders, each revolving on its own vertical axis, close against the periphery of the type cylinder, which was fixed upright in the centre of them. On a level with the top of these was a gallery in the form of a concentric circle, with eight feeding-boards, like so many sloping desks, placed round the inner ring of it. Underneath this gallery was a like concentric circle, where the eight delivery-boards were situated. The central type cylinder or drum was nearly 5 feet 6 inches in diameter, and moved at the rate of 6 feet a second, so that it made one revolution in three seconds. The impression cylinders, however, made five revolutions in the same time. The layers-on fed two sheets every five seconds; consequently sixteen sheets were printed in that brief space of time, or 192 sheets a minute, an average being maintained of 12,000 impressions per hour.

The Hoe "Lightning" Type-revolving Press, which at the *Times* office succeeded the upright rotary machine of Applegath & Cowper, differed but little from it in principle.

The type was also fixed on a central drum, which had a continuous rotary motion in contact with the impression cylinders set round it. The chief difference was, that the drum and the impression cylinders in Hoe's machine were not vertical, but horizontal, and by this means considerable speed was obtained. "The course of the sheet, in laying on at the Hoe machine," says the Report of the Jurors on Printing Machinery at the Exhibition of 1862, "is as direct as it can be made short of printing from a continuous web." The ten-feeder Hoe, which was made for the *Times* by Sir Joseph Whitworth, was driven at the rate of thirty-two revolutions a minute, which gave a printing velocity of 19,200 copies per hour.

In this machine a very ingenious method was adopted for arranging movable type on the large cylinder. Each column of type was set up on the level, but six or seven columns were, nevertheless, adjusted side by side. Brass rules of a bevelled shape were placed between the columns, the bevel varying according to the circumference of the cylinder. These acted as the keystone in supporting the stones of an arch. It has been generally believed that the device was first applied to Hoe's machine. In reality it was patented more than ten years previously (1846) by Augustus Applegath, who described in his specification "type retained on a cylinder by the angular or wedge-shaped column rules made to act as tension bars." All the columns of type were then adjusted and tightened up on what were called "turtles" to occupy, in polygonal fashion, a portion of the circumference of the cylinder, the remaining portion affording space for the inking rollers to act. At a later date, stereotype plates, each strictly conforming to the curvature of the cylinder, were introduced. By increasing the diameter of the cylinder, room was found for an increasing number of pressure cylinders around it, insomuch that there were machines with two, four, six, eight, and ten impression cylinders, printing an equal number of sheets during one revolution of the main type cylinder.

In 1868 M. Hippolyte Marinoni's machine was introduced into this country. It was a rotary six-feeding machine, but differed from the preceding, inasmuch as it

worked both sides of the paper simultaneously. Stereotype plates were arranged on the surfaces of two rotating cylinders, the sheets of paper being fed in by six layers-on at six different positions on the machine. The pressure cylinders and the tapes were so nicely adjusted that the sheets, fed in by the six layers-on, followed in an almost continuous stream, only an inch apart.

In the following year the Walter machine was completed. We are not now concerned with the question whether it was the first rotary web-printing machine of a really practical character. Bullock's, doing the same work, had been in use in America several years previously. The great feature of the new press was that single sheets were no longer operated on, but an "endless" roll of paper, both sides of which were printed at once. This travelled through the machine at a speed of about 1,000 feet per minute. The paper was printed on one side while passing through the first and second cylinders, and on the other while passing through the third and fourth. The inking was managed by reservoirs and rollers near the cylinders. The machine pumped up its own ink from a tank beneath the floor, preparatory to the distribution by the inking rollers. Only three men were required in the actual working—one to start and stop the machine, and two to attend to the delivery of the sheets; no layers-on were needed. In all machines which printed separate sheets the speed of working, as already shown, depended mainly on the speed of laying-on; and, as there is a limit to the nimbleness of human hands in this work, the only means of increasing the rate of printing was by duplicating or multiplying the number of impression cylinders for each type-bearing or stereotype-bearing surface. It was found that, when these impression cylinders exceeded six in number, the complication became great, the stoppages frequent, and the cost of the work heavy. Hence the advantage of printing a continuous roll and separating the sheets after printing. Herein was realised after so many years of patient experiment, and after an almost unlimited expenditure, the dreams of men like Adkin, in 1772, and Nicholson, in 1790.

CHAPTER IX.

DELIVERY APPARATUS.

WITHIN the last thirty years a number of inventions have been introduced for the purpose of mechanically delivering the sheets from a printing machine, and thus dispensing with the services of the taking-off boy. They are sometimes termed "flyers."

In one kind of apparatus of this nature, suitable for single-cylinder machines, there is a wooden cylinder fitted with a set of grippers, and placed above the iron printing cylinders, the sheet being taken from one set of grippers by another set, whence it runs down an incline by means of tapes. The flyers are placed slightly lower than the tapes, so as not to catch the sheet whilst travelling, and hence smearing the work. The sheets are finally deposited in an even pile on a delivery-board.

In another form of apparatus there is fixed above the impression cylinder a slight iron frame, fitted with a series of adjustable tape pulleys. One set of tapes runs completely round the impression cylinder, while, at the point at which the grippers are made to release the sheet, an independent series of endless tapes joins the other set. On the off side of the cylinder frame is erected a short slide, which opens the grippers and releases the sheet into the tapes. The sheet is shot out from between discharge bars driven at a greater speed than the cylinder. The taking-off board slopes in the direction of the ductor, and at the end is a wooden stop, against which the sheets are propelled.

In Messrs. Dryden & Foord's taking-off apparatus, which is suitable for a double-cylinder perfecting machine, the sheet, immediately on leaving the outer form cylinder, passes through a series of thin smoothing rollers driven by the machine tapes. The last roller over which the sheet passes is made of wood, and is slightly greater in diameter

This is driven by a thin band, and travels at a lower speed Above the wooden roller is suspended a drop-bar, which falls on to the sheet just before the end of the latter leaves the cylinder. The sheet is thus held firmly, and passes on to the delivery-board.

Mark Smith's Taker-off (fig. 17), manufactured by Mr. James Salmon, of Manchester, is to be highly commended

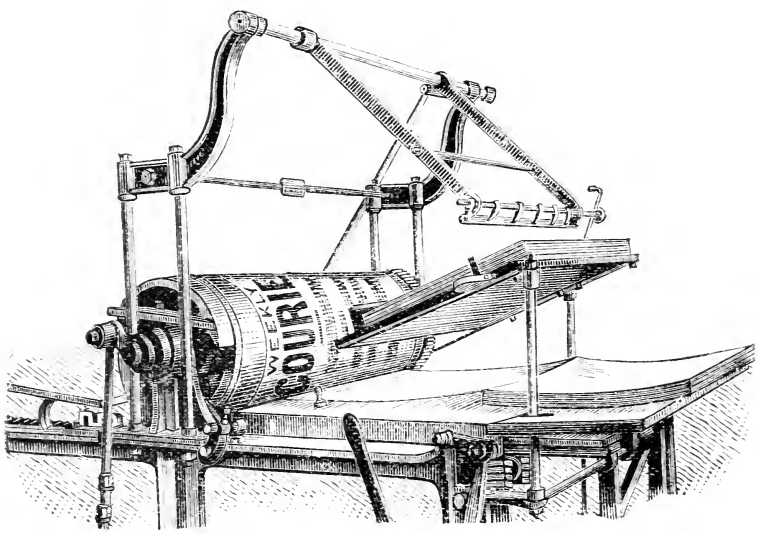

Fig. 17.—Mark Smith's Taking-off Apparatus.

from the fact that no tapes are employed. It merely consists of a light frame fitted above the cylinder. This frame is provided with a set of grippers, which after every impression descend and lift the sheet off the cylinder, depositing it evenly on the taking-off board. The apparatus is simple in its action, and the numerous approving testimonials speak highly in its favour.

Hoe's Flyers.—These consist of an open frame fashioned somewhat like a gridiron, and arranged so that, as the sheet passes from the impression cylinder, it is made to

slide down the face of the gridiron, which is retained in a vertical position for the purpose. At the instant the sheet arrives at the bottom of this, the gridiron is acted on by a cam, and made to fall flat on the delivery-board, the air serving, in the first place, to keep the sheet against the bars as the flyer descends, and to allow the sheet to remain on the delivery-board, without clinging to the flyer as it ascends, owing to the openings between the bars.

Delivery arrangements in Rotary Machines.—In the Marinoni machine of 1868, which printed separate sheets, it has already been stated that the pressure cylinders and the tapes were so nicely adjusted that the sheets fed in by six layers-on, followed in an almost continuous stream, only about one inch apart. After the sheets passed over and under the printing cylinder they were divided by tapes into two streams, one passing to the right and the other to the left; each of these, again, was divided into an upper and lower stream, and the four streams of sheets were deposited by hinged flyers—similar to those in the Hoe machine—on four receiving-tables, whence they were removed at intervals in large piles when two papers were worked on one sheet. The cutting was done by a rotating circular knife parallel to the medial line of the machine.

In the Walter press, the paper after being printed encountered an apparatus which cut up the continuous web into separate sheets. One of two cylinders had a groove along the top; another, over and in contact with it, had a knife along the bottom. A brass guard flanked this knife in such a way as to cause it to protrude and recede alternately, the protrusion of the knife cutting the paper at rigorously equal intervals. The knife was not a smooth edge; it made a row of perforations almost close together, and the paper was pulled asunder at the next onward movement. The sheets, following in a close stream, were led up by a set of tapes to the highest part of the machine; from this point they descended perpendicularly, and were thrown alternately backwards and forwards by an oscillating tape frame, on two delivery-tables, whence they were removed at intervals in large piles. This system has been greatly altered and improved, notably in the new Hoe machines, as described hereafter.

PART II.

DESCRIPTIONS OF MACHINES NOW IN USE.*

CHAPTER I.

THE PLATEN MACHINE.

The Platen Machine.—Its Capacity and Dimensions—Arrangement of the Working Parts—Method of Working.

THE fundamental principles of a Platen machine have already been shown in fig. 6 (p. 28.) They are:

(*a.*) A flat form of type.

(*b.*) A flat impressing surface.

Platen machines may be divided into bookwork, or large machines, and jobbing, or small machines. The characteristic of the first is a horizontal type bed; of the second, a vertical type bed.

Bookwork Platen machines are, again, of two kinds—the single platen machines, and the double platen machines.

In the single platen machines, which are now almost entirely obsolete, and of which the Scandinavian may be regarded as the model, the form was placed at one end of the carriage. The other end was used as a distributing surface for the inking of the rollers. In the centre of the machine was the platen, giving an impression by mechanism connected with the main shaft. The working was as follows:—A sheet was placed upon a tympan in the middle of the machine, which was depressed. This carried the sheet over the form, which was always stationary, and the platen then descended and gave the impression. The sheet having been printed, the frame returned to its place, was raised up, the sheet removed, and a fresh one laid on. The rollers were attached to the tympan frame, and ran to and fro over the form. The only differences between this

*The following information concerning modern printing machines is, as stated in the preface, based upon, where it is not a reprint of, the matter contained in Mr. F. J. F. Wilson's "Typographic Printing Machinery," forming one of "Wyman's Technical Series," but which has been out of print for some time past.

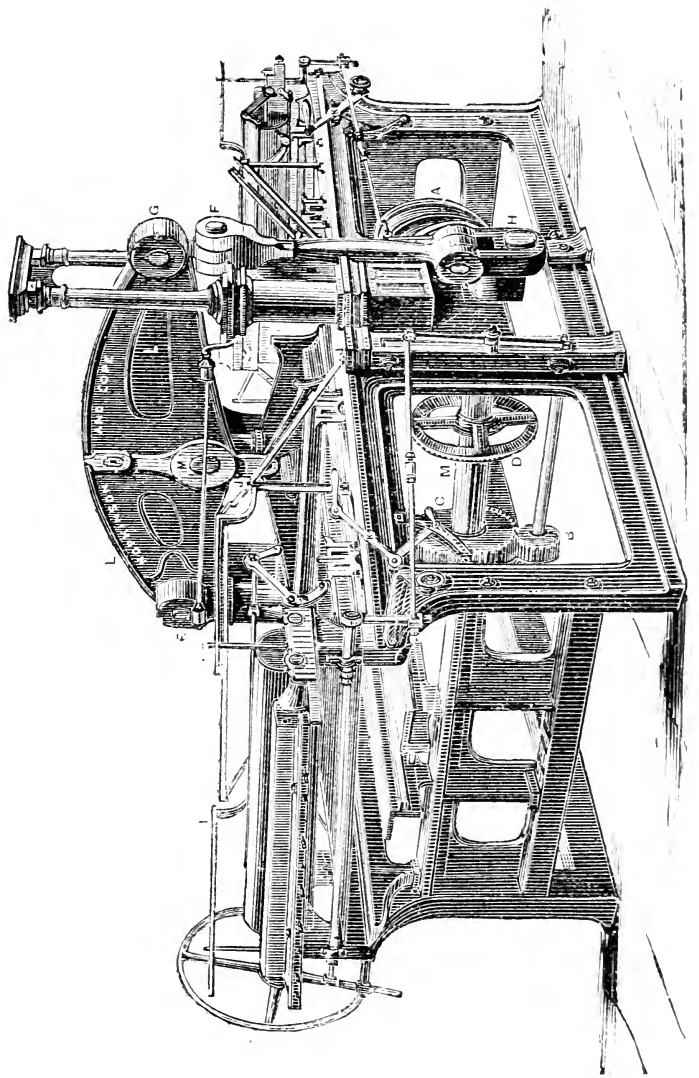

Fig. 18. The Double Platen Machine.

machine and a press were that the bringing down of the platen, the movement of the tympan under it, and the inking of the form were automatic.

There are two kinds of *Double Platens*, which we may describe as the Hopkins Cope Platen, because it was patented by the former firm of that name; and the Napier Platen, invented by Mr. David Napier.

Capacity and Dimensions.—Platen machines were generally constructed to print double demy, sometimes double royal, but seldom as small as double crown.

The length of a double demy platen machine is about 13 feet.

In this machine the platen is placed in the centre; the inking tables and the type-bed are at either end. Both the type-bed and ink tables are worked by the same gear, which lies under one of the tables, and consists of an iron drum about 20 inches in diameter, and 3 feet 6 inches in length, which constantly revolves in one direction. Round the extreme ends of this drum are two grooves, about 1 inch deep. At a certain point each of these grooves is directed into others, exactly the same depth and width, which traverse the length of the drum in this direction (fig. 19), losing themselves in the circular groove at the other end. Immediately above the drum is a slide (fig. 20), about 16 inches long and 2 inches thick, running upon two parallel bars. As will be seen by the enlarged diagram (fig. 20), to one end an iron rod is fastened, which runs through the impression-bed,

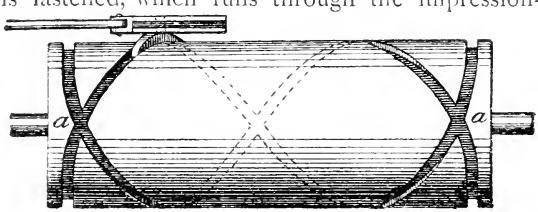

Fig. 19.—Drum of Platen Machine.

securing another slide similar to the first, under the coffin at the other end of the machine. Into the hole *a* (fig. 20), underneath is loosely fixed a shape (fig. 20,*a*) which works into the groove of the drum, so that when the latter revolves the

shape is, owing to the circular direction of the groove, propelled along to the other end, where it remains stationary until the drum has made one revolution, when by means of a half-diamond shape (fig. 19, *a*) it is again led along until it reaches the other extremity. It then remains still, allowing the platen to descend and take the impression before it is again put in motion.

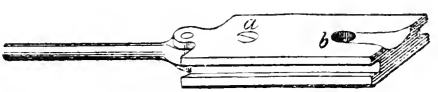

Fig. 20.—Slide.

Fig. 20, *a*.—Shape.

Fixed underneath the centre of each inking-table is a pin, secured by a strong spring. When it is desired to run either of the coffins or "ends," as they are called, under the platen, by means of a striker (shown at K in view of the double-platen), this pin is let down into the slot in the slide (fig. 20, *b*), which, by means of the shape, takes the coffin under the platen, returning after the impression has been given. Either or both ends can thus be worked or kept standing, although the platen itself may be in motion.

The manner in which the grooved drum (A, in view of machine) is driven is extremely simple. On the driving-shaft, inside the frame, is a small pinion wheel (B), which works another large wheel on a shaft immediately above (C), and to which the bevel-wheel (D) is fastened. The latter works in a corresponding wheel at right-angles, fixed to the end of the drum-shaft, which thus acquires a rotary motion.

The platen itself in shape is somewhat similar to that of the ordinary hand-press, but much heavier. At the top is a cup, into which fits a stout bolt, rounded at the base, in order that it may work freely. This bolt is fixed to the beam of the platen (L) by means of the bolt (M); so that although the beam is stationary at E, the platen itself has a strictly perpendicular motion. In order that the platen may be kept perfectly straight, on either side of the frame is a groove (Λ), corresponding with a gun-metal shape fixed on each side of the platen.

The platen is worked by the connecting-rod (F) fixed to the cross-beam at G. The connecting-rod acquires its

motion from the shaft (M), carried through the frame o the machine, and terminating in the crank at H.

The laying-on board is situated immediately above the ink-table, being supported by a slight iron frame (I), fixed to the top of the side-frame. The tympan and frisket are fastened to the end of the coffin, near the platen, by gun-metal hinges or "joints."

When stationary, the frisket and tympan lie at an angle with the form beneath, as will be seen in fig. 18. About two inches from the platen, on either side of the machine, are two iron bars (J), secured to the side-frame at one end, and to the support of the laying-on board at the other. Immediately the impression is given, and when the coffin is carried out to the end of the machine, the frisket and tympan run up these bars, and down again to meet the form for the next impression, time being allowed for the taker-off to lift the tympan and remove the newly-printed sheet, and also for the layer-on to place another on the frisket.

The roller-forks for the inkers are beneath the tympan-slides, and the wavers lie underneath the laying-on board.

In some machines the vibrators are worked by a cam at the base of the frame near the crank-shaft; while in others the bell-crank is used. The duct-rollers acquire their motion by the latter motion.

METHOD OF WORKING.—We have already stated that only a skin of parchment intervenes between the form and the overlay. Hence the thinnest piece of paper tells; and this fact necessitates great care and the exercise of much judgment in making ready on this kind of machine.

Covering the Tympan and Frisket.—The tympan must be covered with parchment, which should be thin and uniform in thickness, and stretched on the frame in such a manner as not to be readily drawn out of shape; neither must it be too loose, or it will be liable to hang in the frame. The way to ensure this is to paste the parchment well round the edges, and place it on the frame. After it is thoroughly dry, sponge the body of the parchment, which will bring it to the required tension. Linen is sometimes used for covering the frame which fits into the top of the tympan, instead of parchment, as the platen continually descending on it, is apt to cut the parchment at the edges.

Over the frisket or light iron frame, which is fixed under the tympan, must be pasted a sheet of brown paper.

Centring the Form.—When the form is laid on the coffin, it must be exactly centred. A small nick will be found on the bar at the end of the coffin, and another on the edge of the ink-table. By stretching a piece of thread from one to the other, the centre of the coffin may be found to a nicety.

Arrangement of the Tympan and Frisket.—After having fixed both the frisket and tympan upon the pins running through the knuckle-joints, sufficient paper should be fixed in the tympan, by sewing it through the parchment, at the top end, so that it can be lifted from the bottom and thrown back again. Thin set-off paper is the best for this purpose. Care must be taken that the pins upon which the frisket and tympan work are securely fastened, or they will loosen and come out while working. Copper wire may be used for this purpose.

Roll the form with a hand-roller, and allow the frisket and tympan to run under the platen, and a slight impression will be left on the frisket. Having done this, cut the marked part out and about a pica beyond, so as to obviate any risk of the edges of the frisket touching, or "biting," the edges of the pages.

As the brown paper is apt to break from continual wear, pieces of tape must be fastened along the space between the pages. This is done by making a hole in the brown paper at the edge of the frisket, exactly opposite the gutters and backs, and tying the tape securely on the *under side*, fixing it tightly at the opposite side by the same means. All the backs and gutters of the frisket should be treated in the same way. After they are tied on, put some melted composition on the under side of the tapes and press to the paper. The frisket will then be sufficiently strong for any number of impressions.

To prevent the possibility of the sheet touching the form before the platen descends, small cubes of cork must be fastened on the under side of the frisket, on the tapes already mentioned. Let the cork be cut in pieces about $\frac{3}{4}$ or 1 inch long; and when laid on the furniture between

the gutters they should be about a pica above the surface of the form. The number of pieces required must be determined by the size of the pages. The cork should be well fastened on with composition, or the pieces will come off during the working.

Making Ready the Form.—After having levelled the pages by underlaying in the ordinary way (*i.e.* if the form be stereo or electro plates), fasten the points on the top and bottom of the frisket, run up colour, make register, and pull a sheet for patching. If there be engravings in the form, first cut the overlays and place them face downwards on their respective places before pulling the sheet, in order that a correct impression may be obtained. Patch the sheet, and paste the overlays in their position. When this is done, lift up the paper inside the tympan, and place the sheet, face downwards, next the parchment, allowing the point-holes in the paper to drop on to the points that pierce the tympan.

Adjustment of the Impression.—The impression may be increased or reduced by screwing up or loosening the wedges in the centre of the platen. They lie under the cup, immediately above the platen, which is raised or lowered by the means described.

When it is necessary to run an end of the machine under the platen, care should be taken that the slide is exactly under the pin before letting the spring down; otherwise it is probable that when the slide comes out, instead of the pin gliding into the slot, the end of the slide will strike it, and, besides pushing the table beyond its proper limits, bend or break the pin. As the duty of starting the end devolves upon the laying-on or taking-off boy, he should be strictly enjoined to wait until the proper time before letting down the lever.

Inking.—As we have already mentioned, the inking on these machines is somewhat defective. Great care should therefore be taken in the regulation of the supply of ink from the duct. Some platens are supplied with revolving ink-cylinders, with a mouse-roller parallel with the duct. This we think a great advantage, although slightly more troublesome to the workman. In fact, we have known this motion to be discarded altogether, although the appliances have been fitted to the machine. We are sure, if the machine-

minder were to realize the advantages of this improved distribution, he would not object to the additional trouble involved by its use.

It will be noticed that the extremity of the form only receives the advantage of being inked by one roller, the ink on which is partially exhausted by having previously performed several revolutions. This might be obviated if the makers of these machines were to provide a double set of roller-bearers, so as to keep the two back inkers off the surface of the first half of the form. By such an arrangement, the end nearest the platen would have the advantage of being always inked by rollers newly charged.

Creasing of Paper.—It will be sometimes found that the paper will crease after a start is made. This is chiefly owing to the air getting between the sheet and the frisket, and may be remedied by the cutting of holes in the paper round the sides of the frisket, through which the air may escape.

Side-marks.—Bottom and side-marks can be made of strips of glazeboard, bent something after this shape, so

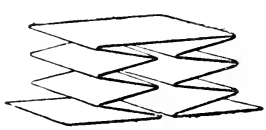

Fig. 21.

that they are not injured by the impression, but resume their original form after the tympan is raised. When pointing for perfecting, of course, these must be removed.

Avoidance of Set-off.—For the prevention of set-off, a thin sheet should be pasted at each corner, and fastened to the tympan. When dirty this can easily be renewed.

Method of Driving.—Perhaps of all ordinary printing machines the platen kind require the most power to drive. They should be driven from a counter-shaft by means of a stout cross strap, which must be tightly laced. Driving from same shaft as other machines should, if possible, be avoided, as the power necessary to give a heavy impression will frequently cause a check to the engine, which will seriously affect the register of work on any ordinary machines that may be running at the same time.

CHAPTER II.

THE NAPIER PLATEN.

Its Advantages — Capacity and Dimensions — Arrangement of the Working Parts.

THIS machine is constructed on the same principle as the last one described, but it differs from it in many material points.

Advantages.—One of the great advantages of the Napier platen, the importance of which can hardly be over-estimated, is, that greater pressure can be obtained with less than half the driving power required by the machine last described. This is owing to knuckle joints being adopted in place of the crank-shaft, for giving the impression (Fig. 22). An arrangement is also added by which the form is twice rolled between each impression.

The grooved cylinder of the Napier is greater in circumference than that in the old platen. By this arrangement the platen is allowed to rise at least one inch above the tympan, after the impression has been given, before the coffin is moved back from under the platen. This lessens the probability of the edge of the tympan catching the sides of the platen and causing an occasional "double-up."

An improvement is also made in the mode of carrying the tables to and fro, a clutch being used instead of the pin and slot. This prevents the possibility of the table becoming detached from the slide, as sometimes is the case in the ordinary platen, by the pin jumping out of the slot.

Capacity and Dimensions.—These machines are mostly made double-royal size, but one has recently been constructed to print a quadruple-crown sheet.

Although Napier platens are sometimes run at as many as 800 impressions per hour at each end, it is very unad-

visable to drive them at so great a speed, and for these reasons:—Firstly, the roller-carriages travel so quickly that notwithstanding the rollers pass four times over the form, they have not sufficient time to properly deposit the ink, and the object of increased inking is lost. And it must be remembered that, as there are no roller-forks, as on other machines, it is impossible to use a rider. Secondly, the wear and tear is so great that the machine is liable to quickly get out of repair.

About 500 impressions at each end is all that can be reasonably expected, if good work is required. If the machine is driven beyond this speed, the work suffers, as well as the machine itself.

Arrangement of the Working Parts.—As will be seen from the illustration of the Napier Platen, the platen itself (A) resembles the ordinary machine only at the base, the cross-beam being dispensed with. The tables and type-bed are driven by the same means as described in the preceding article, *i.e.* by the grooved drum (B) enlarged in fig. 23, but here the similarity of the working of the two machines ends.

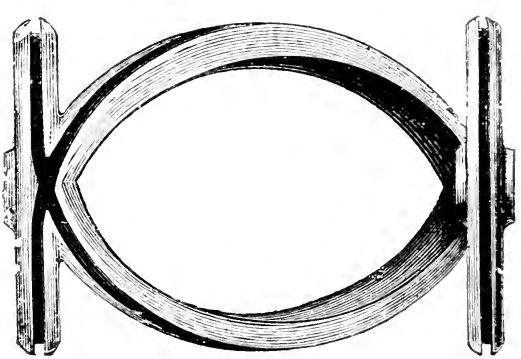

Fig. 23.

The driving-shaft (C), which is situated at the extreme end, works another shaft (D) immediately above it. This is furnished with a bevel-wheel (E), by which the grooved drum is driven. The spindles of the rollers, both inkers and wavers,

are fitted in two parallel bars (G), which work in a groove on the top of the side-frame. These bars are secured in the centre by arms, which are attached to a light frame (H), the sides of which work freely on a pin on the inside of the side-frame at the base of the machine (I). From the cams (F) on the shaft (D) extend long arms (J), reaching to each inking-frame; the one that works the farthest end being necessarily double the length of the other. Towards the end of each of these arms is a small slot (Fig. 24),

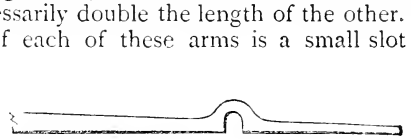

Fig. 24.

which drops on to a pin on the side of the frame at K, which is attached to the inking apparatus. Shuttles on the arms work in the cam-wheels above referred to, and the latter are so made that the arms are propelled backward and forward twice between every impression, carrying the inking-frame; the rollers thus travelling four times over the form between each impression. When either of the ends is struck off, the arm described above is raised from off the pin on the inking-frame. From this it will be seen that great care is requisite in striking off, that it be done when the end is fully out, otherwise the frame holding the rollers will be left on the form, and most probably travel towards the platen. Breakages not unfrequently happen from this cause.

In the original platen machine, as has been already explained, the platen receives its motion from one side only, the cross-beam being firmly secured in the other. The arrangement is entirely different on the Napier. The platen-head, which is cast in one large piece, is supported by means of two powerful rods (L), one on either side. Below the top of the side-frame each of these rods is diverted, as it were, so as to form an elongated square in which is sufficient space to allow for large and powerful knuckle-joints, which are worked by connecting-rods (M) extending from the shaft at the end of the machine.

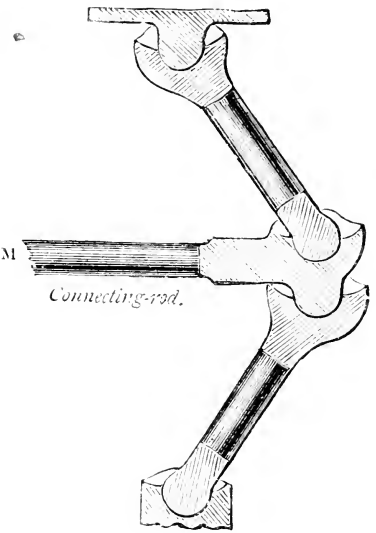

Fig. 25.—Napier's Knuckle Joint.

By this simple but powerful motion, the strain or jar that is so frequent in the other platen is altogether avoided.

In order to steady and assist the platen in rising after having given the impression, a heavy weight (N), extending across the machine, is secured to two strong gut bands, fastened at the other end to the chills of the knuckle-joint. Theoretically, this weight should be as heavy as the platen-head, in order to secure a perfect balance. The gut bands run over a series of pulleys, and care must be taken that the latter are always well lubricated, or the friction will soon cause the gut to snap. But however careful the workman may be, they will occasionally break; and, in order that the weight upon being liberated may not drop down the machine-pit, it is necessary to make a support from logs of wood, so that the fall may be but two or three inches. Although it is possible to work without this balance-weight, the chills, and consequently the platen, will be observed to tremble considerably if it is dispensed with.

The distribution of the ink is facilitated by a drum being

placed parallel with the ductor, from which it is supplied by the vibrator. This drum has a side motion, to and fro (see fig. 11, p. 41).

The end roller nearest the ductor has a pulley on either end, and by a small shape on the frame is raised to the ink-cylinder. The roller-frame works the ratchet, which turns the ductor roller. As mentioned above, both inkers and wavers are placed in the same frame, but the distributing-rollers are placed slightly higher than the inkers, in order to prevent the former from touching the surface of the form.

The impression is regulated by steel wedges on the top of the chills. These can be forced in or withdrawn by means of set screws.

The *method of working* this machine is similar to that of the last, with the modifications necessitated by the altered construction, as detailed above.

As we have mentioned before, the machine-minder must constantly watch his rollers, especially in hot weather, as the rapidity with which they necessarily travel over the form soon renders them useless if they are not in fit condition. Much trouble and delay may be saved by having a duplicate set at hand.

For printing bookwork the large power-driven platen machine is now practically superseded. The very finest work is done on the cylinder machine.

The advantages formerly attributed to the platen over the cylinder machine were chiefly these :—

1. It obviated the slur which was so frequent when the early types of cylinder machines were used. Recent improvements in the latter have, however, completely removed this objection.

2. It dispensed with the supposed necessity of placing a blanket between the overlay on the cylinder and the forme, a plan that was formerly universal. In the platen machine a parchment sheet only intervened between the paper to be impressed and the overlay and patched sheet. Of late years the blanket has been gradually got rid of, and the best work is now done with only a few sheets of hand paper or a millboard round the cylinder. This is called the hard-packing system, and it has placed the cylinder machine in

this respect in as favourable a position as the platen machine.

On the other hand, the platen has always been known to have certain disadvantages as compared with the cylinder. It is much slower, for one thing. The inking is somewhat indifferent. This latter drawback was to a certain extent remedied in the Napier Platen, as has been already pointed out. But such complete inking arrangements as are found on the best modern cylinder machines are quite impossible, or at any rate have never been attained, in the platen machines. On these grounds, as already stated, the platen may now be considered obsolete.

CHAPTER III.

THE PERFECTING MACHINE.

Varieties—Arrangement of Working Parts—Method of Working—Inking up—Set-off Paper—Putting on the Tapes—Regulation of the Impression—Hard Packing.

PERFECTING machines are those which print the paper on both sides, or "perfect" it before delivering it on the taking-off board.

There are two principal classes of perfecting machines.

1st. Those with two large impression cylinders, each printing one side.

2nd. Those with only one impression cylinder, which prints both sides.

The first class are divided again into those of the Applegath & Cowper, and those of the Napier and the Anglo-French types. The distinction will be understood from an explanation of their respective construction and methods of working.

The *Feeding arrangements* of perfecting machines differ according as they are fed by the web, the drop-bar, or gripper arrangements, as described and illustrated elsewhere.

Arrangements of the working parts.—The surfaces of the impression cylinders are of two different thicknesses, that part which meets the type-bed as the latter travels in and receives the impression being thicker than the remaining portion ; so that when the form returns, it passes underneath the cylinder, without coming in contact with it. In order that the weight of the cylinder may be evenly balanced, a thick iron bar is usually fastened inside, in the centre of the thinnest part.

Two sets of stout pins pierce the cylinder at the ends of the impression portion, to which are fastened the bars for securing the calico lining. Upon the latter the making-ready and blanket are placed. The pins can be regulated by means of thumb-screws inside the cylinder.

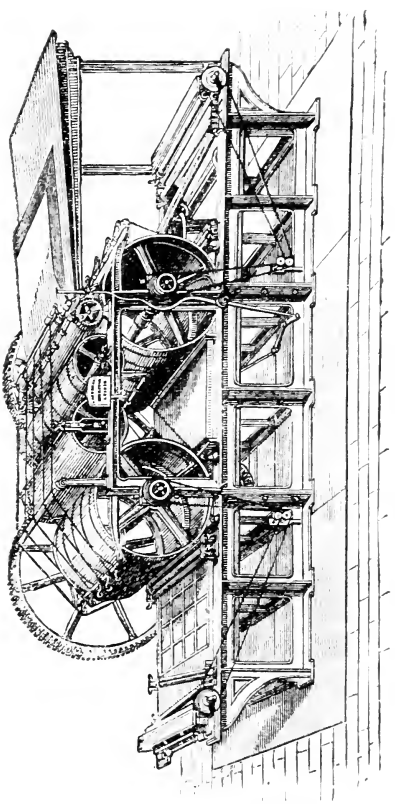

Fig. 26.—Dryden's Drop-bar Machine.

The tables are fixed upon two parallel bars, called table-bars, which run upon a set of heavy pulleys on each side of the machine. Two of these pulleys, directly under each of the cylinders, are much larger and firmer than the others, in order to resist the extra strain of the impression. These are called the impression-pulleys.

The tables are propelled by an upright spindle (fig. 27, GG) and rack (A B), driven by the bevel-wheel (E), fixed at the end of the driving-shaft (H). As the strain upon the spindle is very great, having to resist the backward and forward motion of the table and coffin, it is necessarily very thick, and besides being fitted at the base (G) into a socket, is secured in the middle by a strong bearing. The rack (fig. 28) is placed horizontally under the tables, the cogs downwards: it is supported at either end (M) by two iron bars, sufficient play being allowed between the bars to admit of the rack moving from one side of the machine to the other. The rack, as it were, travels *round* the spindle, the latter being stationary in its bearers. When the end is reached the rack moves rapidly to the other side of the spindle by means of the circular end (fig. 28, K D), reversing its motion again when the other end has been attained.

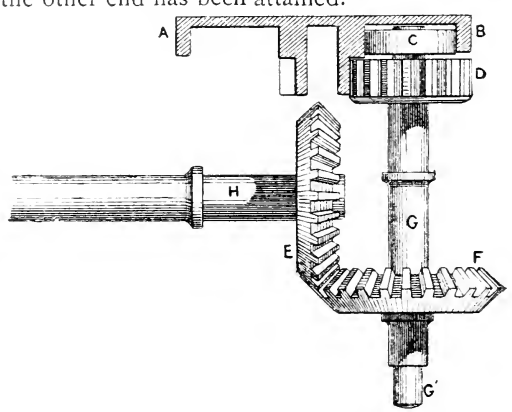

Fig. 27.—Upright Spindle and Section of Rack.

A, B, Section of Rack.
C, Pulley.
D, Pinion wheel.
E, F, Bevel wheels.
G, Upright spindle.
H, Driving shaft.

In fig. 27 we have endeavoured to show the working of both the spindle and rack. AB is a section of the rack in position. A large tumbler (C) fits close to the sides of the rack, and assists in keeping it in its proper place. The pinion wheel (D) fits into a set of corresponding cogs in the rack (shown in fig. 28, D). The upright spindle, as we have before explained, is secured in a socket at the base, and on a bearing in the centre. It obtains its circular motion by means of the bevel wheel (E) at the end of driving-shaft (H) working in the wheel (F). From this it will be seen that the rotary motion of the spindle, by means of the pinion wheel (D) working in the teeth of the rack, moves the latter backwards and forwards, rounding the ends, as shown in fig. 28, D K.

In order that the whole of the rack may move from one side of the machine to the other at the same time, when the pinion-wheel traverses round the end, and that it shall always be exactly in position, two long bars are made, having a short arm attached to the opposite end of each. The ends of these arms (M M, fig. 29) are bolted underneath the coffins, inner and outer, and the other ends (N N) of the bars are fixed to the rack. Across the centre, these bars are joined, in order that they may work uniformly. A broad groove is made in the centre of the rack, large enough to allow

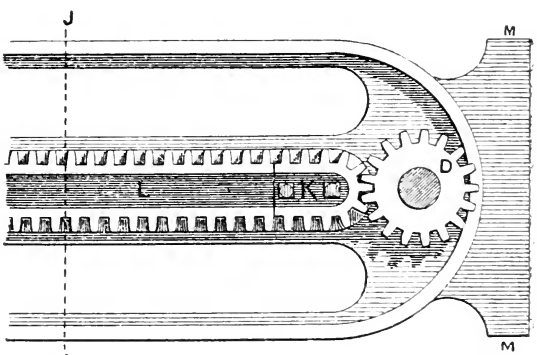

Fig. 28.—Portion of Rack showing position of Teeth and Driving-cog.

D, Pinion wheel.
J, Width of rack.
K, Rack end.
L, Teeth of rack.
M, End of rack supported between bars.

this cross-bar to work freely. As the correct working of the rack depends greatly upon this motion, which is called the "parallel motion," it is a very important point in the construction of a machine of this class that it be in every respect well proportioned and accurately fitted. Many

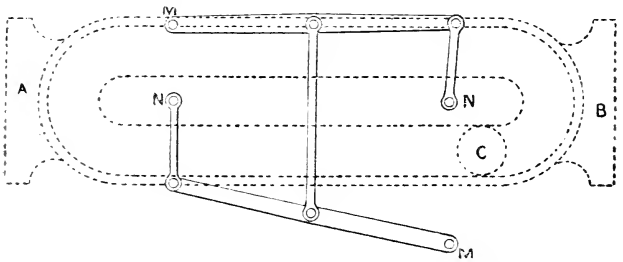

Fig. 29.—Upper side of Rack, showing Parallel Motion.

M M, } Long and Short
N N } Bars.

C, Pulley of Upright Spindle.
A B, Extreme ends of Rack.

machines have been condemned as being almost useless, through the parallel motion being wrongly calculated. It will be seen that without this, the rack would have a tendency to move to either side of the machine in an irregular manner.

There have been many discussions as to the respective merits of the broad and narrow racks. The broader the "ends" are, the more gradual is the return; and we think that, taking into consideration the shock a machine necessarily receives upon the reversion of the tables, that the wider are the better, the shock being less violent.

As the "ends" are subject to more wear than the other portions of the rack, from the constant jar consequent upon the return of the tables, they are made in separate pieces (fig. 28, K), and can be easily changed, supposing a tooth becomes damaged. Spare ends should always be kept in readiness, as accidents frequently happen to this portion of the machine.

The outer-form cylinder-wheel is driven from a small cog on the driving-shaft, and the former works in the inner-form wheel. The impression-cylinders have therefore a contrary motion.

On each side of the inking-tables are dovetailed pieces of gun-metal, flush with the side-frame, in order that the type-beds may run perfectly true, and not shake when in motion.

The intermediate drums acquire their motion from a cog-wheel inside the inner-form cylinder-wheel. These drums are made of wood, iron being unnecessary, as they are subjected to no great strain, their office merely being to turn the sheet for perfecting.

One of these cylinders is termed the "register drum," as it can be raised or lowered on either side by means of screws, thus facilitating the process of making register.

On p. 44 is a diagram showing the travel of the sheet, and that of the tapes which convey the sheet.

It will be seen that the tapes, being endless, taking in the sheet at *a*, liberate it on the taking-off board at *b*, parting company at that point, one travelling under the outer-form cylinder, over the drums, and the other passing over the roller *c*, thence under the inner-form cylinder, and joining the other again at *a*.

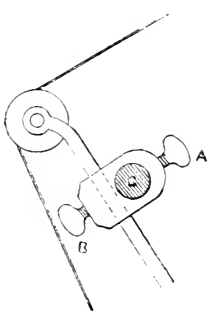

Fig. 30.—Tape Pulley.

A B, Thumb-screws; C, Tape-bar.

On the tape-bars *g* and *h*, are a series of pulleys, over which the tapes travel. These pulleys are fixed to the end of long spindles, and by means of thumb-screws (fig. 30, A B), can be lengthened or shortened, greatly facilitating the regulating of the proper tension of the tapes.

Some drop-bar machines are so constructed that the outer-form is printed first. This necessitates the laying-on board being placed above the outer-form cylinder, and the consequent different disposal of the tapes. This arrangement is illustrated in fig. 15, p. 44.

METHOD OF WORKING.

Inking-up.—The ductors are worked by gut bands running on wheels on the end of the ductor-rollers, with grooves of smaller and greater diameter, by which the supply of ink can be regulated. The bands run over similar wheels on the shaft of each impression-cylinder. If a greater supply of ink is needed, the band is placed round the larger groove on the cylinder-shaft, and the smaller one on the ductor; and if a lesser, *vice versâ*.

Sometimes these bands will come off while the machine is working, in which case care must be taken that they are not crossed in the replacement. If so, the ductor-roller will turn the reverse way, and empty the contents of the duct on the table, causing a terrible mess. We have seen this result from boys being allowed to replace the bands; but the machine-minder should never allow any one but himself to interfere with the ductor bands.

Set-off Paper can be used on these machines by means of a roller, which should be fixed about twelve inches under the drum nearest the outer-form cylinder. Pieces of narrow paper, the width of the pages, are cut in lengths, and passed over and under the outer-form cylinder, and the bar mentioned above. In order that the paper may not wander, thick bands of India-rubber should be placed on the bar, and they can be easily moved to any position. The paper, being confined between two of these rings, will travel without coming in contact with the tapes. Should it do so, it would be quickly damaged. Care must be taken that the paper is neither too tight nor too loose; in the case of the former, it will break, and in the latter, will either crease on the impression, or will wander into the tapes, with the result mentioned above.

In putting up set-off papers, as little paste should be used as possible, and the lap-over must be as short as is con-

sistent with safety, as when the extra thickness comes upon a page the impression is marked. This is more noticeable in the case of cuts. The set-off paper must be carefully watched, and immediately it gets black or torn from continual wear, it should immediately be changed, or the work will be soiled.

When a change is desirable, it can be done by taking the new length, slightly pasting it to the old one, tearing the latter, and pulling it gently until the former is completely round the cylinder, when the dirty paper can be removed.

Putting on the Tapes.—Supposing one to break and come off, the new length can be fastened to the tape next the place it is to occupy, and the machine slowly moved until the pinned end comes above the cylinder; it can then be easily shifted to its right position and tightened by the tape pulleys (fig. 30). It must then be detached, and affixed to its other end. The machine-minder should be particularly careful that the tapes run freely, although not too loose, and that they are guided exactly between the gutters of the form. If a tape wanders, it is probable that it will be cut, by being pulled on to the form. If this is discovered immediately little damage will accrue beyond the destruction of the tape, but if the detached end falls unseen among the rollers, it may pull them out, either damaging the machine or battering the form. In the event of a tape becoming turned, it should be seen to immediately, as it is liable to run off the pulleys.

Regulation of the Impression.—In perfecting-machines this is done by means of the screws over and under the bearers on each side of the cylinders. When it is desired to increase the impression, loosen the bottom, and screw down the top. To lighten the impression, reverse this process.

Lubrication.—We cannot too strictly impress upon the machine-minder the necessity of thoroughly lubricating all parts of his machine every morning before starting. Tallow should be used to the rack, upright spindle, and cylinder-wheels. The tape-pulleys, cylinder-brasses, drum-bearings, and tape-bars should also be carefully oiled.

The circumference of the cylinder and the travel of the bed must be in perfect accord and harmony. The packing of the blankets for forms of any kind must not be

higher than the bearing portion of the cylinder. That is, the impression part of the cylinder must not be raised too high by blankets or paper. In every case where this is done, the circumference of the cylinder is enlarged, and out of harmony with the movement of the form surface, a slur must inevitably result, and usually at the foot, where the bed leaves the cylinder.

Paper is being largely adopted as a covering for cylinders. Machine-minders are beginning to realise the fact that in the case of fine cut-work the use of the blanket tends somewhat to destroy the effects of a thin and carefully-cut overlay. It will be admitted that the thicker the substance intervening between the form and the overlay, the less the latter "tells." Supposing, therefore, that simply a sheet of hard paper be pasted over the overlays on the cylinder, the effect must necessarily be greater: and, instead of three or four overlays or patched sheets being required, it will be found that, if the work be properly done (including the underlaying), two at the most are sufficient. One thing, however, it is necessary to bear in mind: the very fact of this system being more effective, renders it absolutely necessary that the greatest care be taken in the cutting-out, for as surely as the beneficial effects of a good overlay are shown, so bad workmanship will be apparent, necessitating further patching.

We unhesitatingly prefer paper as a substitute for blanket—not, of course, for common work, but for good illustrated cut and general work. Objections have been urged that the hard packing is liable to injure the plates; but this is not the fact. A certain amount of pressure must be exerted to produce a given effect, and whether a blanket be used or not, the impression must necessarily be the same. Another point in favour of the hard-packing system is, that the impression need not be altered after properly starting a form; whereas, when blanket is used, it is apt to wear or give in the heaviest parts, necessitating a slightly increased "nip" after the form has been running for some time. In several large offices at the present time the blanket has been discarded from the Anglo-French machine in favour of hard packing.

CHAPTER IV.

THE NAPIER AND ANGLO-FRENCH PERFECTING MACHINES.

Origin and Comparison—Arrangement of the Working Parts of the Napier—Introduction of the Anglo-French Machine—Its Advantages—Capacity and Speed—Its Construction.

THE Napier Machine may be said to be the original of the Anglo-French Machine, which upon its introduction superseded it. This was chiefly owing to the fact that the Napier lacked the number of rollers necessary for good distribution and any appliance to prevent the set-off; added to which its construction was far too light to enable it to produce heavy cut-work.

Speed.—The Napier Gripper is driven about the same speed as the Anglo-French—from 700 to 900 per hour.

Arrangement of the Working Parts.—The cylinders are made to rise and fall by a rocking-frame, and the tables are moved by means of the rack and quadrant, with universal joint and horizontal pinion-wheel. The rocking-frame is not worked by a separate cam, as in the Anglo-French, but by an arm from the collar of the pinion-shaft, upon which, consequently, there is a great strain.

The grippers are opened and closed by shapes on the cylinder-frame, instead of an independent folding frame. The ductors are worked by rods, which are driven by small bevel-wheels from a series of teeth at the base of the rack.

The ductors are placed only 12 inches from each cylinder, and no wavers are employed. The vibrator deposits the ink upon a wooden roller, which lies between two inkers. This roller has a worm at either end, and, as the tables travel to and fro, moves slightly in the direction of its length. In consequence of this wooden roller constantly

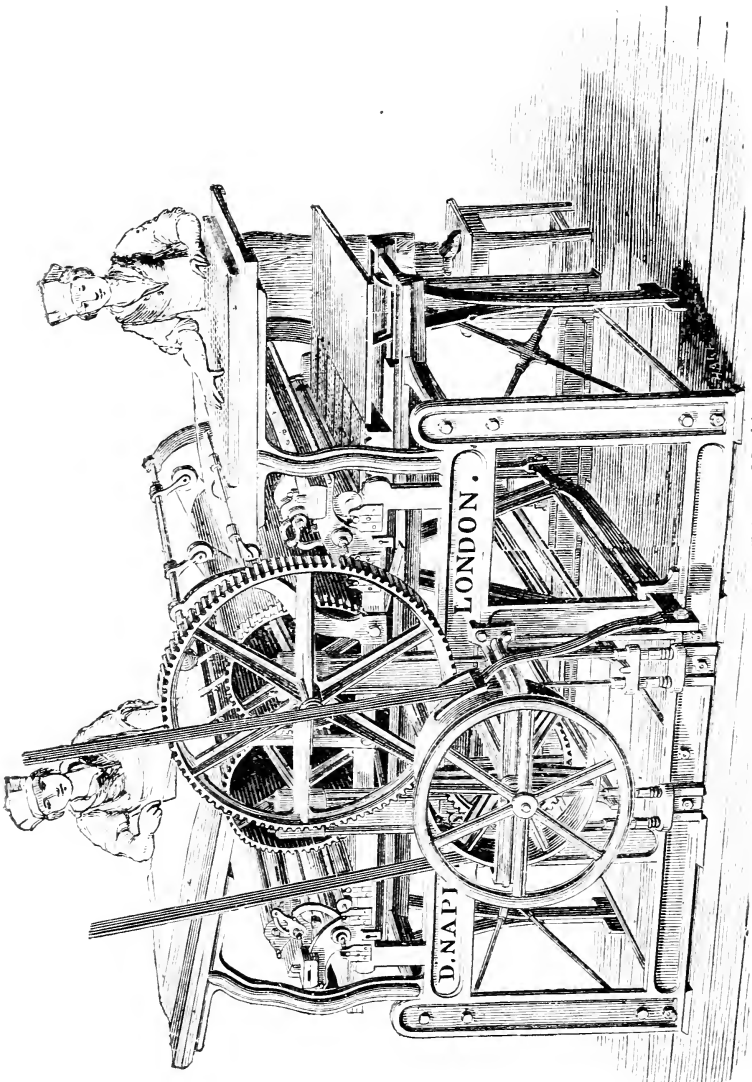

Fig. 31.—Napier Gripper Machine.

moving along the surface of the two inkers, it will be seen that it has a tendency to injure the face of the composition. The inkers, with the assistance of this roller, distribute and deposit the ink as the table and forms move underneath. The ink tables, which are rather small, are made of wood.

In many instances a set-off motion has been added to the Napier machine, being constructed in the same manner as that made to the Anglo-French.

With this machine the minder has many little difficulties to contend with, and unless he is very careful, will probably fail in some material points. In the first place, the inking arrangements are so limited that unless the rollers are in prime condition the distribution will be defective. As the ink is deposited almost direct from the ductor, it is absolutely necessary that the knife be set to a nicety, or the work will be unsatisfactory, in consequence of an irregular supply of ink. The somewhat frail and complicated gripper motion is also liable to get out of order, and the apparatus should be constantly watched. When out of repair the grippers are liable to "turn" on the form.

It is frequently found that a minder who has worked one machine for some time is able to produce much better work than a stranger, who is comparatively unused to it; not because the former is the more competent workman, but because he is accustomed to the peculiarities of the machine's construction, or an occasional weakness in any of its working parts. This is especially true in the case of the Napier Gripper, showing that experience only can render the workman really skilful in the management of some machines.

The Napier Gripper is a very light and particularly compact machine, standing in so small a space as to be available where other machinery calculated to print as large a sheet could not be erected. In some cases this is a most important matter, and it seems, therefore, proper to mention the fact in the present notice.

THE ANGLO-FRENCH MACHINE.

Some years ago the French enjoyed an unrivalled reputation for producing the best kind of machine-printing.

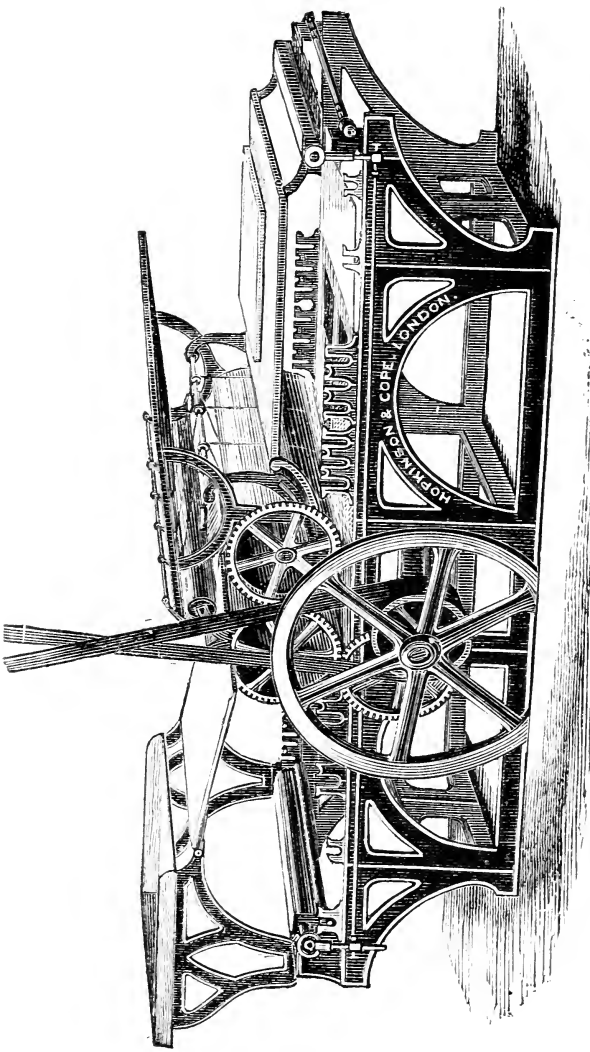

Fig. 32.—Anglo-French Machine.

This was attributable to two circumstances. In the first place, they adopted the plan of highly glazing their paper; in the second place, they devoted all their inventive power to the suppression of that *bête noire* of the machine printer,—the set-off. While we were occupying ourselves simply with rapid printing, and relegated fine work to hand-presses and platen machines, they improved upon the ordinary gripper machine to such a degree as to demonstrate the possibility of printing even the finest cut work on a double cylinder.

As we have before mentioned, the original machine of this type was made by Messrs. Napier, and is commonly known as the "Napier Gripper." The superiority of the Anglo-French over the Napier will soon be apparent upon comparison of the working parts.

Advantages.—Inking arrangements similar to those of the ordinary perfecting cylinder have been applied, the ducts being placed at the end of the travel of the tables, instead of midway, as in the Napier, thus allowing room for at least three distributing rollers. An extra number of inkers has also been added. The apparatus for opening and shutting the grippers is considerably improved, the shapes by which this is accomplished being fixed on an independent movable frame. Added to which, the machine is very much stronger and heavier in every detail.

The Anglo-French is a far more complicated machine than the perfecting machine described in the preceding, and consequently cannot be safely driven at so great a speed; besides which, the tables have a longer travel.

Capacity and Speed.—The size mostly made hitherto has been quadruple crown, but these machines can be had as large as quadruple super-royal. They are usually run at the rate of 750 or at most 1,000 impressions per hour.

Arrangement of the Working Parts.—As will be seen from the diagram, the Anglo-French machine possesses two cylinders, the diameters of which are about one-half of those of the ordinary Web or Drop-bar. Nearly the whole of the surface is utilized for the impression, so that in order that the form on its return may clear the blanket, it is necessary that one cylinder be slightly raised. This being the case, it will readily be seen that the cylinders are never

on a dead level, but alternately rise and fall. The rise and fall of the cylinders is effected by a "rocking-frame." An extended portion of this frame pierces the side of the machine, and forms the base of a knuckle-joint. This joint works in the manner shown in the diagram (fig. 33) of which the following is an explanation :—

Each cylinder is supported on either side by a cylinder-frame (E) : A is the extended portion of the rocking-frame ; B, the joint : C, the piece of steel, which is secured to the side-frame of the machine at F. When A and B incline to the angle as shown in diagram, the cylinder-frame, assisted by springs, ascends. When perpendicular, the frame is forced down, as the slot at F, into which the top of the joint works, is fixed. The set-screws at D are for regulating the impression.

In order that the frame E may rise quickly, powerful springs are placed on the side-frame between the cylinders, which, while assisting the rocking-frame, also steady the cylinders while working.

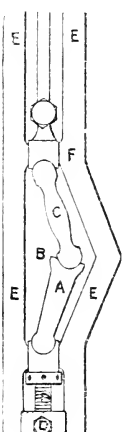

Fig. 33.—Knuckle Joint.

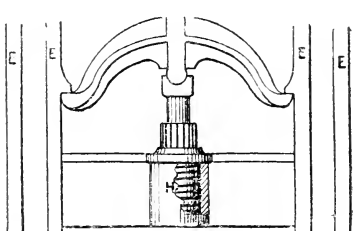

Fig. 34.—Rocking Frame.
H, Spring. E, Continuation of Cylinder-frames.

As the rocking-frame is made in one piece, it necessarily follows that the contrary motion of the cylinders must be

simultaneous, *i.e.*, as it rocks to enable one cylinder to ascend, the same motion forces down the other.

This machine gives the impression to the sheet in the manner directly opposite to that of the ordinary perfecting machine. In the latter the sheet is printed as the coffin runs *in;* but with the Anglo-French this is reversed, and the sheet is printed as the coffin travels to the end.

The tables are driven by means of a horizontal rack, with quadrants at each end. This rack, as will be seen from the diagram (fig. 35, F), is totally dissimilar to the one used on the Drop-bar machine, and consists of only one set of long teeth. The rack is fixed in the centre of the coffins. On the driving-shaft, just inside the frame, is what is called the universal joint, B. From this joint, carried to the rack in the centre of the machine, is a shaft, C, with a pinion-

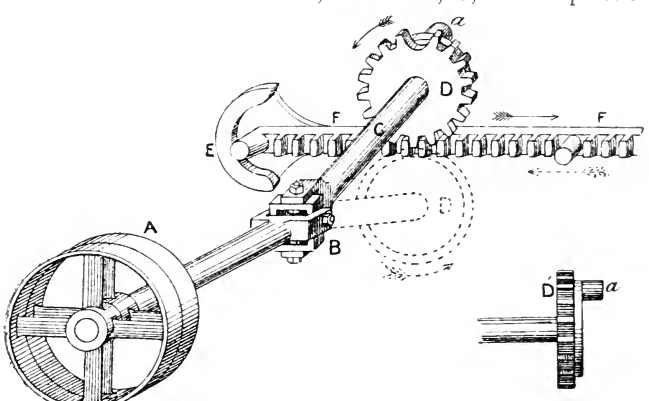

Fig. 35.—Anglo-French Rack and Spindle.

A, Live and Dead Riggers.	C, Pinion Shaft.	FF, Rack.
B, Universal Joint.	D, Pinion Wheel.	*a*, Tumbler.
	E, Quadrant.	

D*a*, Side View of Pinion Wheel, showing position of Tumb'er.

wheel, D, at the end. This wheel works in the rack, and moves the latter to its extent. When it arrives at the end of the rack, the small tumbler *a* glides round the steel quadrant E, and travels *underneath* till it attains the other end, when the tumbler again travels *up* the quadrant, and

then as before. The dotted lines represent the pinion-wheel in position travelling *under* the rack.

It will be noticed in fig. 35, near the tumbler on the pinion-wheel, the space between two of the teeth is greater than between the others. This cavity always falls on the end and on the centre teeth of the rack, which are necessarily larger than the rest. Thus the pinion makes two revolutions to traverse the rack, and in order that the end teeth n ay better resist the shock of the reversion of the tables, they are made much stronger. The centre tooth is large, simply because the wider space in the pinion falls at that point on the completion of its first revolution, as mentioned above—not that any extra strength is needed at this part. The pinion-shaft C is supported near the wheel by a steel collar, to give strength and support. The end and centre teeth are so made that they can be screwed in or out, so that, in case of accident, they can easily be replaced.

When we say that the pinion-wheel travels *along* the rack, we do not wish to be taken literally, but that in reality the rack travels over and under the pinion-wheel, as the latter (the motive power) only revolves, changing its actual position simply from the top to the bottom of the rack, or *vice versâ*, when it arrives at either end.

As the quadrants at the end of the rack are subjected to a great strain, having, in conjunction with the pinion, to resist the shock of the reversion of the tables, they are faced with hard steel. Supposing either to become broken, they can be detached without much difficulty. The machine-minder should make a point of occasionally ascertaining the state of the quadrants, and should have them changed whenever they show signs of wear. It is advisable to have spare quadrants in stock, in case of accident.

Two strong springs, placed horizontally, are usually, though not invariably, fixed at each end of the machine, to partially ease the shock of the tables as they run to the extreme end, and to assist them on their return.

The tables travel upon a series of small runners or wheels, fitted into parallel bars on a strong frame on each side of the machine. In the case of large machines, the space between these frames is of course greater than in the smaller,

and the middle of the coffin, from not having a central support, is apt to sink. In some instances we have even known them to split. In several patterns there is added an additional set of bearers in the centre, extending the length of the machine; thus obviating this possibility. It is impossible, however, for the rack to be placed in the centre of the coffins, so it is fixed under the off-side, the pinion-arm being lengthened. The additional support to the tables we think a very great improvement.

It may here be mentioned that latterly some Anglo-French machines have been constructed with the upright spindle and rack similar to the ordinary perfecting machine described already. The rocking-frame is dispensed with, and the cylinders are raised and depressed by means of powerful cams on either side, at the base of the cylinder-frame,—a much less complicated plan, and equally as effective. Machines thus constructed can be driven at as great a speed as the ordinary Perfecting, excepting where set-off sheets are used, in which case it would be impossible for the boys to take them off with sufficient quickness.

There being no intermediate drums for turning the sheet, the outer-form cylinder grippers take it directly from the inner. The grippers of the outer-form cylinder enter slightly the opening in the inner, and clutch the sheet, which is immediately released from the latter.

This arrangement is effected by means of a "folding-frame" on one side of the machine. The gripper bars are carried through the ends of the cylinders and provided with short arms, to the end of which are attached tumblers. On the folding-frame are fastened four shapes—one each, to enable the grippers first to take the white paper, then release it to the outer-form cylinder, and the latter to take it and finally throw it off on the taking-off board. These shapes are in such a position that, when the frame is forced in, the tumblers glide over them, causing the grippers to open. When the tumblers have travelled over the shape, the spring inside the cylinder shuts them tight on the sheet. Thus the frame is forced in when the sheet is first taken, and then forced back, by means of a spring, to enable the tumbler to clear the shapes, allowing the inner-form cylinder to take the impression. The frame

again moves inwards, causing both the cylinder grippers to open,—the inner to release the sheet and the outer to take it; one set closing on the paper, the other ready for taking the next sheet. When the frame is forced in, to enable the sheet to be first seized, the outer-form grippers simultaneously release the perfected sheet on the laying-on board; so that it will be seen that the paper is held by grippers throughout the whole of the printing. To prevent the folding-frame from being accidentally pressed in by the knees of the boy laying on the set-off sheets, a piece of stout iron wire should be fixed round the front, being secured on either side to the side-frame. We have seen sheets released and taken round the rollers, owing to the folding-frame having been carelessly touched. Tapes are employed under the cylinder merely to prevent the sheet from falling on the form.

In order that the tapes may not become alternately tight and loose by the rising and falling of the outer-form cylinder, the tape-bar (which works loosely in its bearers) above the taking-off board is provided with weights fixed on short levers; and when the tapes are inclined to loosen, from the cylinder rising, these weights raise the pulleys and keep the tapes at an even tension.

The set-off laying-on board lies above the outer-form cylinder, the layer-on facing the white-paper boy, so that the former has to stroke in the sheets with the left hand. The set-off is taken in by a drop-bar arrangement, similar to that described in the ordinary perfecting machine—*i.e.* by a revolving bar with discs falling upon the sheet. This is so arranged that the set-off meets the white paper exactly when the latter is being taken by the outer-form grippers, and passes *between* the cylinder and the printed side, being delivered to the taker-off simultaneously with the good sheet, when it is lifted by the boy from the top and carried to the extremity of the board. It will be seen, therefore, that the set-off, together with the printed, sheet only travels half round the outer-form cylinder.

The cylinders are driven from an intermediate wheel on the inner-form frame, which acquires its motion from a small pinion on the driving shaft, the teeth being sufficiently deep to allow for the rise and fall.

The vibrators are moved by a small cam situated inside the frame, at the base; the duct by an eccentric on the driving shaft, or in some machines by two long rods driven by a small bevel-wheel.

Some makers lighten the machine by substituting wood in the place of iron for ink-tables. This necessarily lessens the shock the machine is subjected to when the coffins return. But the wooden tables are apt to become injured by the iron ends of the wavers and inkers when the latter are being placed in and taken out of the forks, and the ink is apt to accumulate in these indentations. Therefore, on the whole, we think the substitution of wooden tables a questionable advantage.

The tables of the Anglo-French having a longer "travel" than other machines, the rolling is more perfect, the whole of the inkers (four in number) completely clearing the

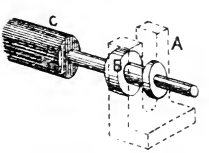

Fig. 36.—Roller End.
A, Roller-fork; B, Roller-lift; C, Waver.

entire form. Only in cut-work is this number of rollers really necessary. But this is one of the advantages which the Anglo-French possesses over other machines, for in some of the ordinary perfecting only one inker completely traverses the form, the others turning on the page, which is apt to cause a friar.

In order that the foremost waver may not touch the front pages of the form a roller lift is used (fig. 36). When the tables travel to their full extent this lift runs upon the roller-bearers, lifting the waver above the surface of the form, and the inking-table being slightly narrower than the coffin, the lift is suspended between the fork and the table when it leaves the bearer.

In some machines an iron cylinder or drum, having a rotary and side motion, is fixed parallel with the ductor.

This materially assists the distribution. In this case two vibrators are required, one to feed the cylinder and the other to transmit the ink to the table.

Messrs. Marinoni have added a series of front lay-marks, which are fixed to a bar directly above the inner form cylinder. They are made of brass, and about one inch wide. Three inches of the fore-part of the laying-on board work upon hinges, and this portion is so raised that when the paper is stroked down, the latter can be laid close to the lay-bars. When the grippers are ready to take the sheet, the front portion of the board slightly drops, allowing the paper to be taken. By this means the lay can be more depended on, as the boy strokes the sheet, both at the side and front, to substantial "marks."

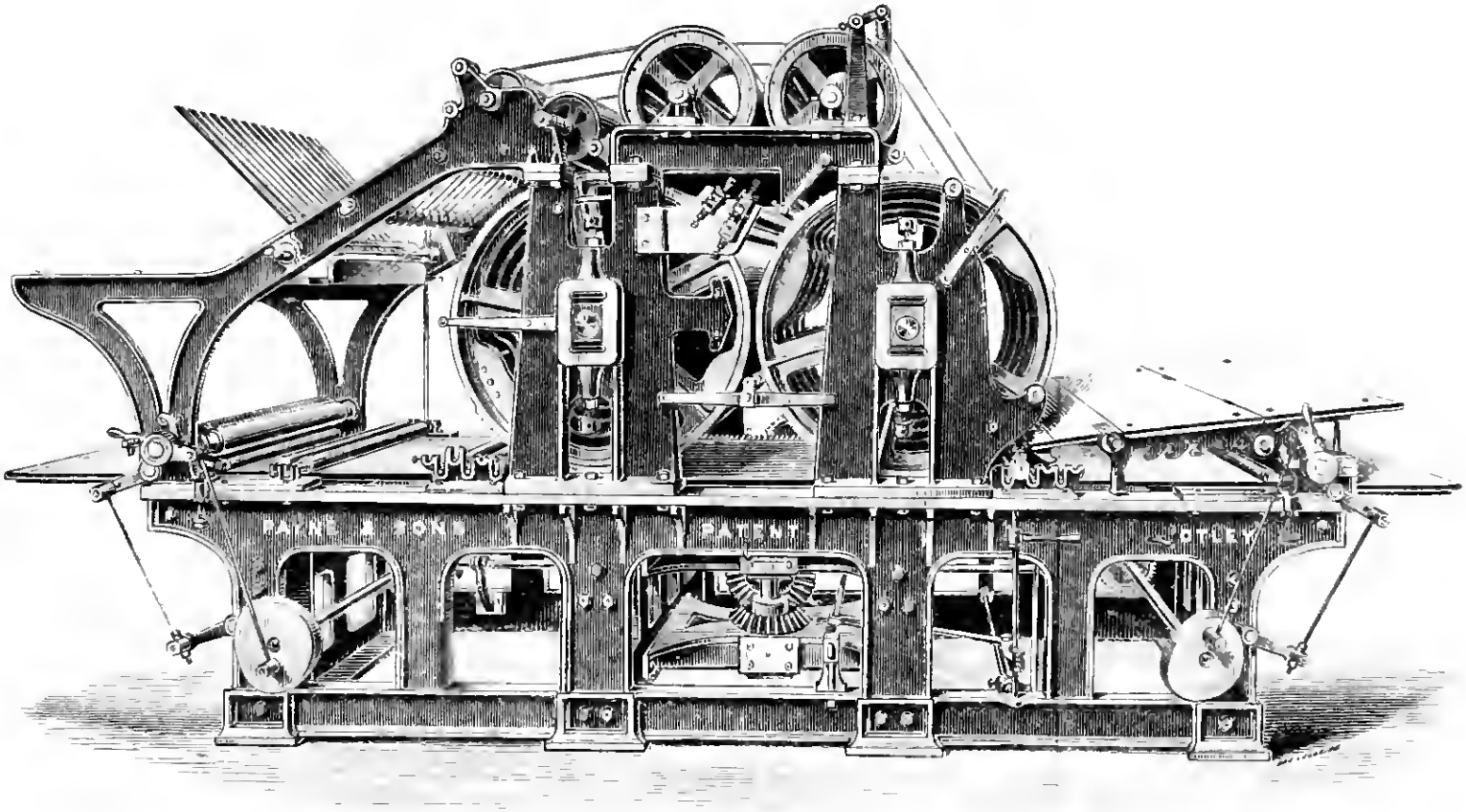

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Fig. 37.—Payne's Large Cylinder Single Revolution Perfecting Machine.

CHAPTER V.

RECENTLY INTRODUCED PERFECTING MACHINES.

Single Cylinder Perfecting Machine—Payne's Single Revolution—Payne's Two-Revolution—Dawson's—Marinoni's Combined Perfecting and Two-Feeder.

IN 1885 a remarkable novelty in the shape of a perfecting machine with only one impression cylinder was announced. The possibility of perfecting with a single cylinder was doubted from the fact that from the very beginning perfecting had been done only by the employment of two cylinders. The new machine was patented under the title of "Improvements on Perfecting Letterpress Printing Machines" (Patent No. 16,201). The patentees are all described as of the *Guardian* Printing Works—Mr. John Henry Buxton, newspaper proprietor; Mr. Davies Braithwaite and Mr. Mark Smith, both engineers. The last-named is the inventor of the well-known "Mark Smith Flyers," noticed elsewhere.

The general idea of the Single Cylinder Perfecting Machine may be stated in a few words. It is to all intents and purposes a Wharfedale of the two-colour type, but the cylinder is double the usual size, and has two printing surfaces and a double set of grippers. Two sheets are printed at each revolution, the first being white paper, and the second being the partly-printed sheet which has immediately preceded it. The essence of the invention consists in the ingenious arrangement for reversing the paper after it is printed on the first side. In the illustration annexed it will be seen that near the crown of the impression cylinder there is a small drum, similar to that used in the Wharfedale Flyer. This takes the sheet and reverses it. Behind this is another small taking-off cylinder. This carries tape

which delivers the sheet to a flyer. The action is as follows: The sheet is fed in as to an ordinary Wharfedale, and retained by grippers; then it is taken off, reversed, again gripped, and perfected. In the words of the specification,—"The sheet when it is fed and has received its first impression is delivered by the grippers upon the impression cylinder to the grippers of a taking-off cylinder in gear with the impression cylinder, and this taking-off cylinder delivers it to rollers, or tapes carried on rollers, having their bearings in brackets secured on a board arranged to oscillate on a fulcrum on the framing. This board is oscillated by connexions with any suitable cam making one revolution for each revolution of the impression cylinder, so as to bring a thin plate projecting from its end into a position to receive the end of the sheet from the taking-off cylinder and then present its other end to the second set of grippers on the impression cylinder to be taken thereby and receive the impression on the other side at the same time as the first side of the next clean sheet is fed and printed. Thus one sheet is fed and printed on one side and the previous sheet is reversed, fed, and printed on the other side, or perfected at each rotation of the impression cylinder."

The advantages of a perfecting machine with a stop cylinder, and consequent double rolling capacity, and one that can work at a speed of about 1,200 per hour on good work, are obvious. The machine may also be used for general jobbing. Nearly all of the objectionable points of ordinary perfecting machines, which have caused printers to give such preference to "one-siders," are obviated.

No pit is required, and noise and vibration are reduced to a minimum. The machine may be erected on an upper floor. In regard to register, it is only necessary to state that the sheet is fed to the same edge for each side, being automatically registered on the reversing board, which is a matter of the utmost importance. It will do fine woodcut work, owing to the rigidity of the cylinder, effected by the adoption of Mr. Samuel Bremner's principle of three sets of runners and rails, one in the middle of the table. For the same class of work the great facilities for inking and distributing render the machine especialiy suitable. The inkers, of which four, five, or six can be made to cover a form, are

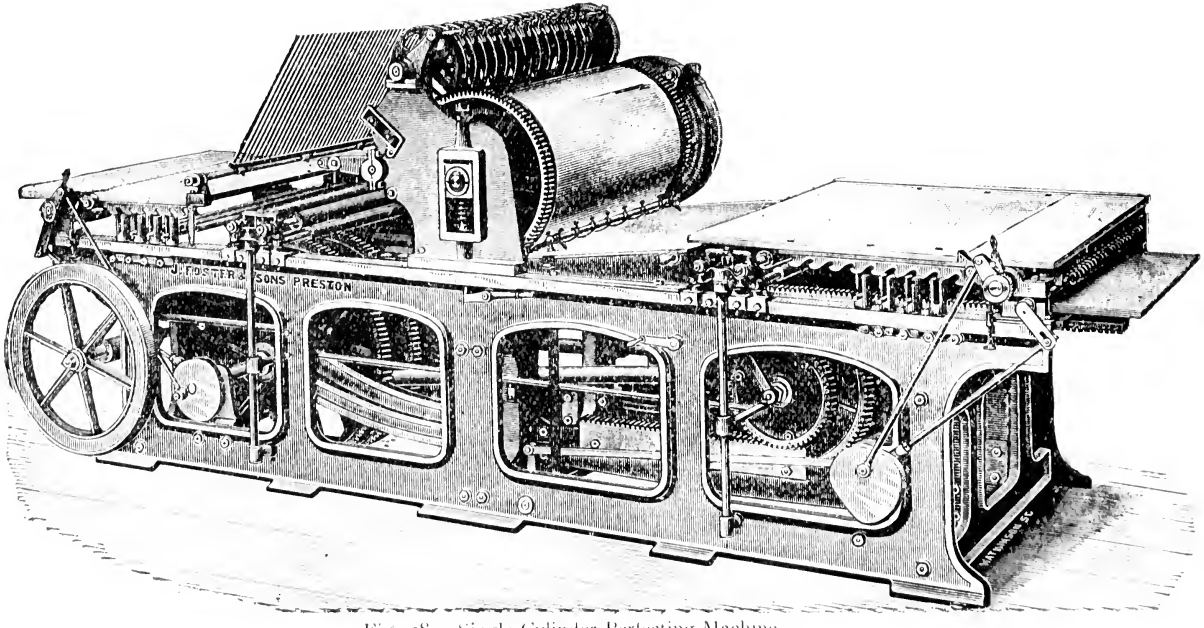


Fig. 38.—Single Cylinder Perfecting Machine.

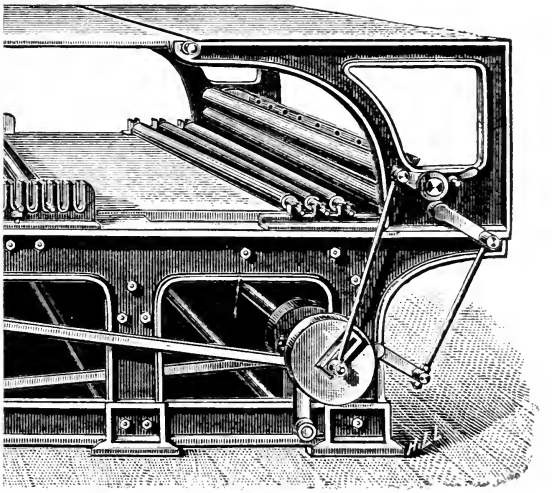
geared. The cylinder can be checked at any part of the stroke without fear af accident, and the form is as readily accessible as in the Wharfedale. Another very good feature is that the sheet is delivered by flyers on a board in a convenient position in full view of the minder, instead of being laid on a board between the cylinders as in the perfecting machines now in use. They are manufactured by Messrs. Joseph Foster & Sons, Printers' Engineers, Bow Lane Iron Works, Preston.

The excellence of the various one-side machines introduced to the market has till recently had a tendency to disparage perfecting machines in the eyes of many practical men. The famous Otley and other firms however are now making perfecting machines which embody the improvements so much appreciated. The illustrations which we give of these are almost self-explanatory. The principles of construction are the same as in the presses already described.

Messrs. Payne make two varieties (figs. 37 and 39) both with upright spindle. One of them has large cylinders, which in some cases give better work. This machine is compact as to floor space. The other is longer, but the form is rather more accessible. Both deliver the work at the end and not beneath, as in the old Applegath and Cowper.

Dawson's Perfecting Machine, (fig. 40) was the first flat bed single revolution perfecting machine with sheet delivery not between the cylinders. It is now fitted with a self delivery apparatus which delivers the sheets within the reach and in full view of the feeder, who is thus enabled to observe the work as the sheets are delivered from the machine. The forms are always free from encumbrances and the working generally is remarkably good.

Messrs. Marinoni have constructed a machine which may be used either for perfecting or as a double feeder, printing twice the quantity of sheets on a single form.



Machine.

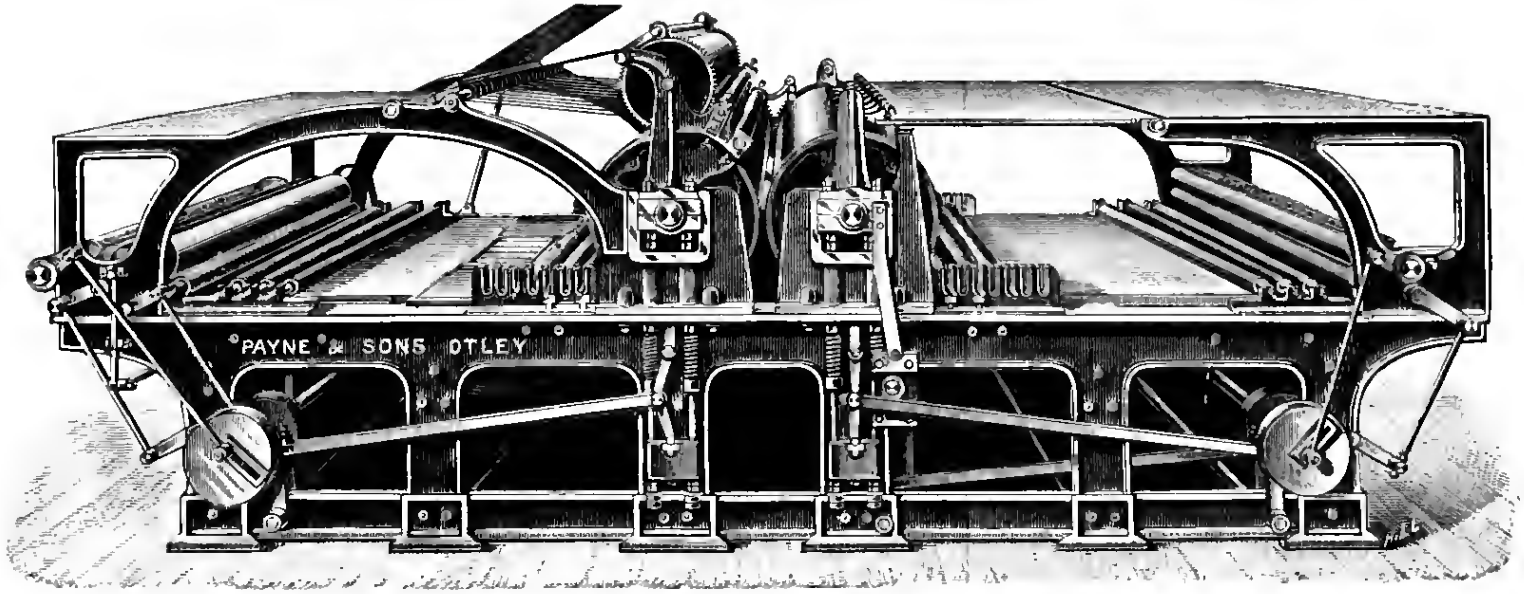


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Fig. 39.—Payne's Two Revolution Perfecting Machine.

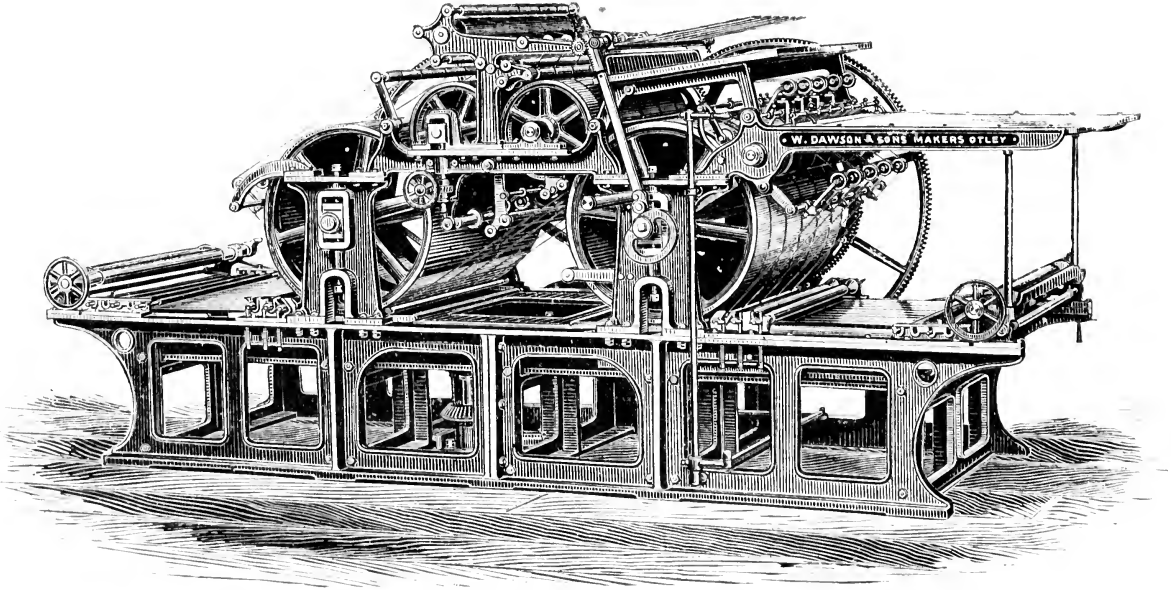


Fig. 40.—Messrs. Dawson's Perfecting Machine.

CHAPTER VI.

CYLINDER ONE-SIDE MACHINES.

Progress in Manufacture – Capacity—Construction—Traverse Wheel —Rocking Lever—Grippers—Stop Cylinder—Taking-off Apparatus — Dawson's Wharfedale — Payne's Wharfedale — The Bremner—The Reliance—The Anglo-American—The Standard—The Quadrant—The Little Wonder—Two Colour Machines.

OF late years single cylinder machines have been generally considered the best adapted for superior kinds of work. The makers have recognised this growing preference, and added various improvements. The original defect, weakness in construction, has been remedied, and, by adding slightly to the travel of the table, better rolling is secured. A second ductor, with rollers, &c., has been attached by several makers, so that a minimum of ink with a maximum of rolling (the real secret of good printing) is obtained.

We have spoken of extra strength in construction. It is patent that the greatest strain is exerted at the point of impression. We have little hesitation in saying that in most of the machines built before this simple fact was appreciated, it will be found that the table has sunk more or less, necessitating, as a matter of course, a thick wrapper being placed by the machine-minder in position under the form. This is not owing to legitimate wear, but simply to lack of proper support, resulting in the bending of the table. This has now been remedied by placing extra runners and bearings, which are supported by strong girders, thus rendering any "give" impossible. In the case of the "Graphic" machine, the entire machine is bolted upon an independent bed-plate.

A slight variation is also being made in the general construction. In some instances the side frames are lowered, giving the machine-minder more command over his form, the laying-on board being fixed above the cylinder, somewhat

similar to the arrangement of the lithographic machine. The printed sheets are delivered under the laying-on board. This is by no means new, however, as Dutartre made letter-press machines on this plan many years ago.

There are comparatively few perfecting machines employed in America, one-sided presses being universally adopted. They are very heavy in construction, perhaps too heavy, and the price demanded would shock the economical English printer. The Wharfedales made in this country are, however, now excellent, and, thanks to the increasing competition among makers, such improvements as can in any way add to the efficiency of the machine are readily adopted.

Capacity and Speed.—Single-cylinder machines are made of any dimensions, from demy to quadruple royal, or larger. The speed at which they are run varies with the size of the machine and with the quality of work required, from 800 to 1,200 impressions per hour being the usual rate. If the form be twice rolled for every impression, the production, of necessity, is reduced one-half.

About 1,000 impressions per hour is the speed at which, say, a double-royal machine can be safely run. With a smaller, this number can be increased; but in the case of the very large make, 750 is all that can be relied on for good quality.

In giving the rate at which we think machines ought to be driven, it must be understood that we do not maintain that it is impossible to drive them faster; but several points should be borne constantly in mind. No matter how well and substantially a machine may be built, it will soon show signs of undue wear if driven too fast; and one that is run at an average speed will last very much longer, produce better work, and will be the cause of less trouble and expense than one which is driven even 100 per hour beyond its normal speed. The makers are naturally anxious that their machines should prove as quick as desired by their customers; but we have found it a good plan always to deduct at least 10 per cent. from the guaranteed speed.

The process of making-ready on single-cylinder machines is easier to the workman than on the perfecting; not because there is less work required in the preparation, but

because both the form and cylinder are more accessible. As a rule, the work is smaller, and the machine-minder is not compelled to twist himself into uncomfortable attitudes in order to reach any portion of the form, as is the case on the perfecting.

We have often found it advisable, especially in illustrated work, to put a sheet of paper over the cylinder in lieu of a blanket, it being obvious that the making-ready is more effective the nearer it is placed to the form. In rule-work, blanket should always be dispensed with, as it has a tendency to thicken the lines by dipping on either side. But in common work, where time can only be allowed, say, for one underlay and overlay, blanket should be used, because of its elastic properties.

As we have before said, work quite equal to that done on the platen can now be produced on the single-cylinder. The slur on the edge of the page can be obviated by keeping the cylinder tight on its bearers. Greater impression can be obtained, together with better distribution and inking: the register can be guaranteed; and the taking-off apparatus prevents the possibility of dirty marks from the boys' fingers. We strongly advise that all machines of this class should be provided with flyers.

For long numbers, or ordinary magazine work, the single cylinder is, of course, not so desirable as the perfecting machine, as the former would take at least two machines and increased labour to accomplish the same as the latter. As before mentioned, they are more adapted to the best bookwork, where speed is subservient to quality and cost not so much considered.

It should well be understood that good printing is almost next to impossible if the foundation of a machine be not solid and substantial. An ordinary wooden floor is in general unsatisfactory: but if this cannot be avoided, the frame on which the machine stands should be well made of hard wood about 10 inches wide and 4 inches deep. A piece of ordinary felt placed under the wooden frame will prevent vibration.

A general description of a single-cylinder machine, such as the Wharfedale, would be as follows:—

The cylinder is situated nearly in the centre of the

machine, and almost the whole of its surface is utilized for the impression. At the extreme end is the main shaft, which, by means of a cog, drives the cam-shaft, in the centre of which is a large wheel. To this is attached a connecting-rod, extending under the table, and which is fixed at the other end to a short shaft, having a large cog-wheel on each side. These two wheels, called traverse-wheels, work in parallel toothed bars (traverse-bars) at the base, and into identical cogs on the underneath-side of the tables. By this means it will be seen that as the wheel to which the connecting-rod is fastened revolves, it moves the two wheels between the racks backwards and forwards; thus carrying the ink-table and coffin. The latter have, in consequence, a perfectly firm and steady motion. In order to balance the weight of the connecting-rod, a large weight is so suspended as to travel with the opposite side of the wheel to which the rod is fixed. In small and light machines the traverse-wheel is replaced by a rocking lever. The upper end of this is attached to the underside of the type-bed; the lower to a rod hinged at the end of the machine. The connecting-rod from the large wheel meets the lever at its centre. The action is similar to that of the traverse wheel, but the parts are less weighty and not so strong.

The tables travel upon a series of runners on either side of the machine, and are secured midway by a thin rod from the short shaft between the traverse-wheels, to keep them in their place on the bearers.

The cylinder is made with but one *fixed* cog-wheel (situated on the off-side); the cog-wheel on the near side, although travelling in the register-rack on the coffin, being really detached, so that, after the impression is given, it travels back with the coffin.

On the outside of this wheel is a tumbler, which works a "pawl," or shape, on the inside, secured by a spring. On the end of the impression-cylinder next the movable cog-wheel, is an iron shape, and when the detached wheel travels back with the coffin, this shape or pawl drops exactly behind the shape on the cylinder, forcing the latter over when the table runs out. By means of a crutch inside the frame of the machine, instead of allowing the pawl to

fall behind the shape on the cylinder, the tumbler may be raised; thus preventing the former from being forced into gear. The striker nearest the cylinder is connected with a lever, which raises the crutch, and the tumbler is lifted above the shape, thus permitting the cog-wheel to return without the cylinder.

The cog-wheel on the other end of the cylinder is fixed to the cylinder-shaft, and several teeth on the under-side are filed away, in order to allow the rack on the coffin to pass underneath; but immediately the cylinder is moved by the pawl, this wheel is forced into gear, and travels with the table.

The grippers are governed by a cam on the shaft at the end of the machine. On the off side of the gripper bar, outside the cylinder (A)—Fig. 41,—is a tumbler (B), which, when the cylinder is stationary, rests upon the small crutch (C), and keeps the grippers open. By means of a bell-crank and a rod from the cam, when the cylinder

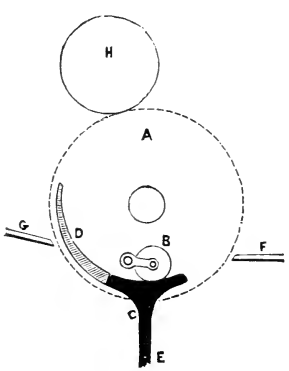


Fig. 41.—Working of the Grippers, and the Taking-off Apparatus.

A, Impression cylinder.
B, Gripper Tumbler.
C, Crutch.
D, Fixed Slide.
F, Taking-off board.
G, Laying-on board.
H, Taking-off.

is thrown into gear, this crutch or shape slightly drops, allowing the spring inside the cylinder to close the grippers on the sheet of paper. When the cylinder has performed

three-fourths of its revolution, the tumbler glides upon the fixed slide (D), which opens the grippers and releases the sheet, the tumbler finally resting upon the small movable crutch (C) before mentioned, which is really a continuation of the slide. The same action of the lever which prevents the pawl from forcing the cylinders into gear also prevents the small shapes dropping, the grippers closing, or the points acting; so that, though the machine may be in motion, the mere action of the cylinder-striker renders the cylinder and all its adjuncts perfectly motionless.

At the end of the cylinder-shaft, on the near side, is a disc, with a small slot on the underside. Connected with the cylinder-lever is a rod running outside the frame, and, when it is raised, it fits into the slot in the disc. This contrivance prevents the possibility of a careless boy striking off the stopping-gear while the cylinder is in motion, as the lever can only be effectually raised when the end of the rod fits into the slot in the disc; the cylinder can, therefore, only be struck off while it is stationary.

The double-inking is effected by means of a small pinion on the cam-shaft working in a wheel twice its diameter. Inside the large wheel is a box-cam, actuating an arm carried to the rod supporting the lever which regulates the cylinder. On the end of the cam-arm is a slot which drops upon a pin on the lever-rod. As the cam-wheel is twice the diameter of the driving cog on the cam-shaft, it follows that the former only makes one revolution to two of the latter. When, therefore, it is desired to roll the form twice, the slot at the end of the cam-arm is allowed to fall on to the pin attached to the cylinder-lever. The double inking thus becomes self-acting, as the cam-rod raises the lever supporting the pawl-tumbler every other time the table returns.

The arm connected with the box-cam can, however, be thrown out of gear by being simply raised and rested on a bracket fixed for the purpose; so that the alteration from single to double inking can be effected while the machine is in motion, merely by allowing the arm above mentioned to drop upon the pin on the cylinder-lever, as above explained.

As a sufficient number of rollers for the inking of ordinary work passes over the form, it is only necessary to use the double-inking motion for superfine cut-work.

On the off side of the cylinder-shaft, outside the frame, is a wheel, on the bottom of which is a stop or piece of steel projecting inside. A cam from the cam-shaft works a strong steel rod, which reaches to this stop. On the other side to this is a bell-crank, one end close to a pin lying horizontally on the frame. Between this and the iron rod before mentioned, the cylinder is held firm when at rest. When about to make a revolution, the cam-rod slightly moves, allowing sufficient room for the wheel to move forward. After the revolution is performed, the bell-crank secures one side, and the cylinder, which moves about $\frac{1}{4}$ inch beyond its proper limit, is pushed back by the cam-rod, or pushing-back bar; thus ensuring perfect register by firmly holding the cylinder in exactly the same place after every revolution.

The sheet is laid to brass front marks. When the cylinder is ready to take the impression, these are slightly depressed, and the front of the board is raised to the level of the grippers. This, as well as the raising and depressing of the points, is also effected by a rod extending from the cam-shaft.

The ductor is worked by an arm attached to a wheel on the cam-shaft outside the frame, and the vibrator by a cam on the same shaft.

The striker is connected with a brake, which clamps the underside of the fly-wheel, so that when the strap is struck off, the machine is stopped almost instantaneously.

The taking-off apparatus, while being simple, is very effective. Immediately above the cylinder is placed a drum (Fig. 42) one-half its size, and which works in a narrow set of special teeth on the off side of the cylinder. This drum is provided with a set of grippers, and takes the sheet from the cylinder in the same manner as the sheets are transferred on the Anglo-French; *i.e.* by entering the opening and clutching the paper simultaneously with its release from the impression-cylinder. The sheet then travels horizontally by means of tapes on to a set of flyers, which duly deposit it on the taking-off board. This plan we consider to be an improvement upon the original mode of running the sheet up a series of tapes, and down upon the flyers.

The taking-off frame can be lifted up during the making-ready, in order that the form and rollers may be attended to without difficulty.

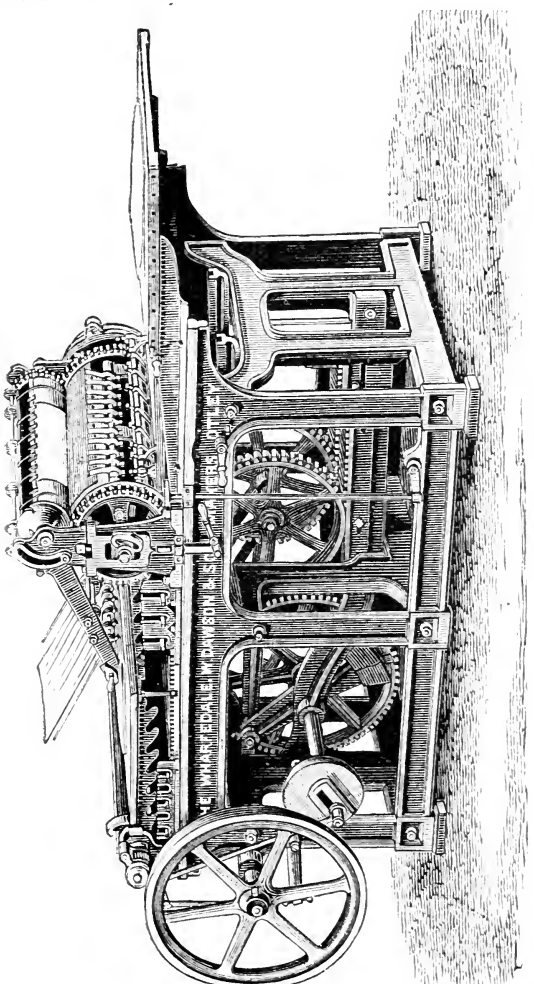


Fig. 42. — [illegible] with [illegible].

Dawson's and Payne's Wharfedale Machines are the best known modern machines of this class. The "Bremner" has almost the same construction. Fieldhouse & Elliott's "Reliance" has a rather different taking-off apparatus, which can be so removed as to leave the cylinder and type-bed unincumbered. On it the printed sheets slide down the fan, which would cause a slur if too much ink had been used.

Newsum's "Anglo-American" Machine was first erected and used to print the *English Illustrated Magazine*, which was issued as it left the machine, not being pressed or rolled. It has the strength of American machines, and is known familiarly as the "Crusher." The feed is "overhead," and the delivery at the same end of the machine beneath, so that the inking apparatus and form are open to view throughout.

"Ullmer's Standard" is a smaller and less weighty machine than the foregoing, and suitable for lighter work.

The "Quadrant" is another small cylinder machine, worked on occasion by treadle. The flyer differs from that on other machines, and allows the minder to get at the form from either side, the "gate" being worked by a horizontal lever, instead of the usual vertical toothed lever which projects over the type-bed and prevents the form being lifted on that side.

The "Little Wonder" Treadle Cylinder Machine was invented by Mr. D. T. Powell, of the firm of J. M. Powell & Son, 33a, Ludgate Hill. It is different in construction to any machine of the cylinder class. The type bed is hinged on a centre at the foot of the machine, and rocks to and fro by means of a connecting rod actuated by a large toothed or spur wheel, somewhat similar to the action of the type bed of a platen machine. This obviates the use of the ordinary runners or friction pulleys, and of rails, besides dispensing with many wheels necessary in the ordinary construction.

The feeder stands at the treadle, at the end of the machine, not at the side as in the usual cylinder machines. Laying the sheet to gauges, the grippers take the sheet, the feed-board rising and falling. When printed, the sheet passes between rollers above the impression cylinder, and out, on to a board which lies over the form and the rollers.

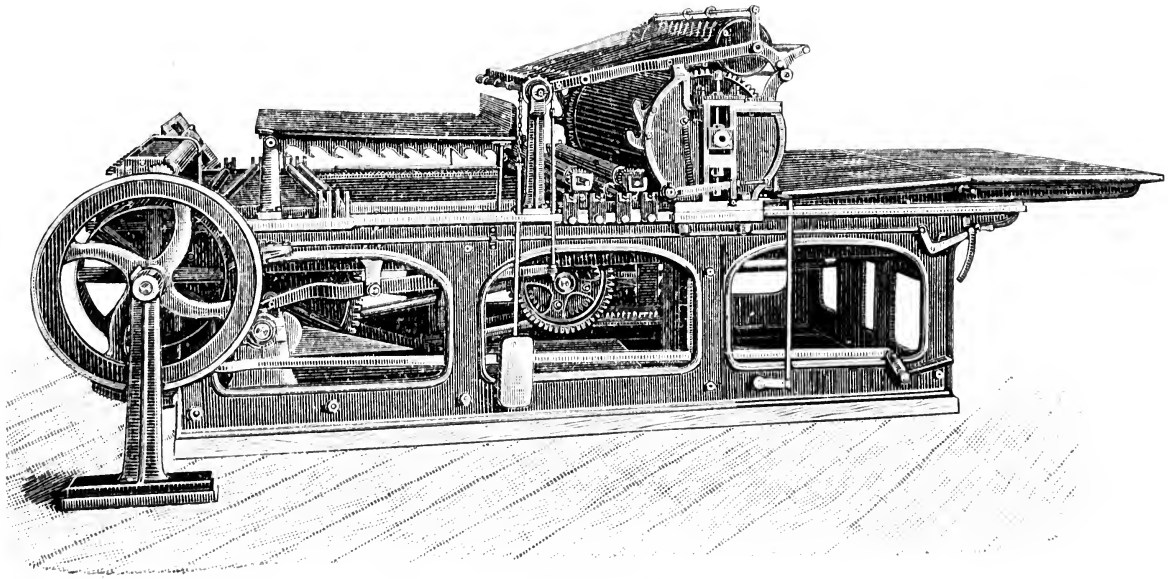


Fig. 43.—Newsum's "Anglo-American."

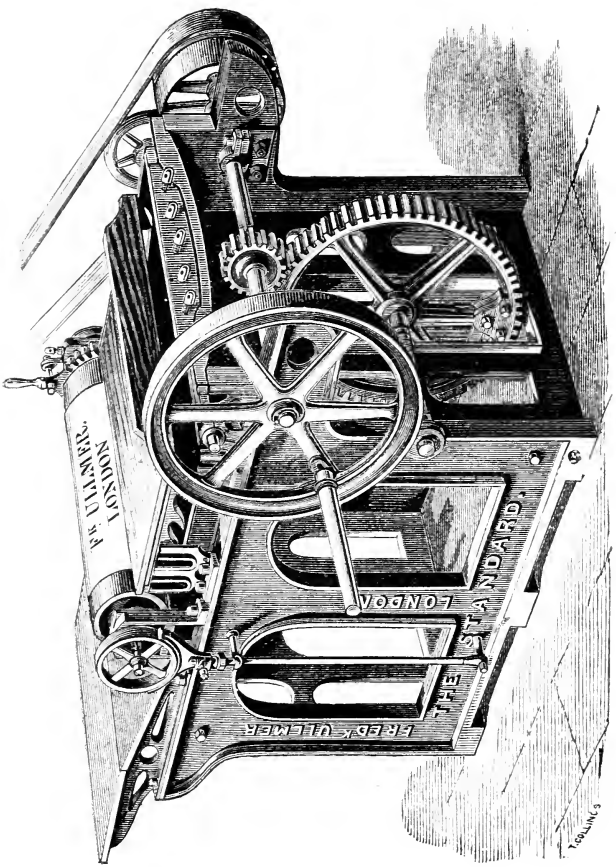


Fig. 44.—Ullmer's "Standard."

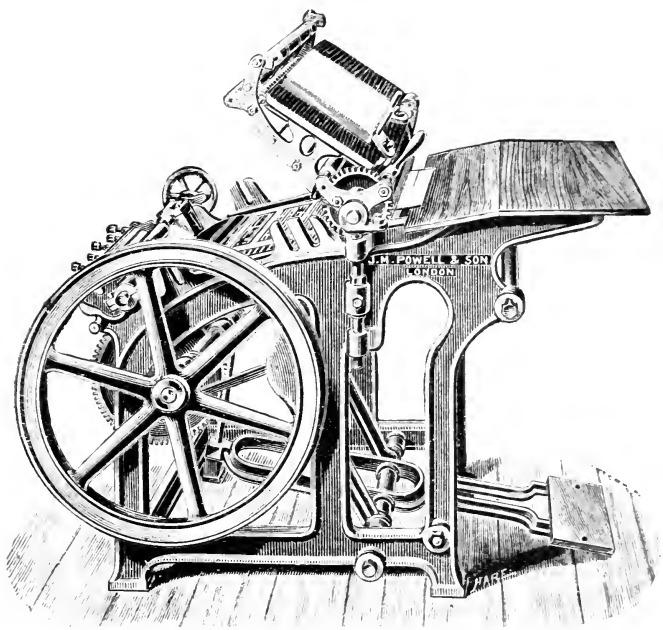


Fig. 45.—The "Little Wonder."

The type bed and inking slab, of course conjoined describe in their movements part of a large circle. The rollers lie loose, so as to follow the face of the form, and the inking slab, which is of quite adequate size, is somewhat curved. The type bed and the form are, of course, quite flat. To compensate for the slight curvature of the inking slab, the cylinder has a free motion and also follows the face of the form. The impression is obtained by a quite novel motion, the impression screws at the end of the cylinder being so placed that they either raise or lower two

impression pulleys, which the under-side of the table depresses, and so the pressure is obtained by the amount of resistance the type table finds on going between the cylinder above, and these impression pulleys underneath. The cylinder has a curious motion, not, of course, being fixed on brackets, but, being free to rise and fall, prints as the type table moves up to it, as well as rotating in the ordinary way. There are guides or rims on its ends, which, in conjunction with the bearers, maintain the proper degree of pressure. It might be thought from this construction that there would be a liability to slur, but the impression is both firm and clear. The flyer is simple, and delivers the work printed side up on a board just above the cylinder and immediately under the eye of the feeder. It consists of elastic tapes, two going round the printing cylinder on the margins of the job, or between lines, if the composition will permit of it. The action is similar to that of the frisket forks of a platen. The elastic carries the sheet between the two rollers and delivers it, unerringly, on the board—as we have already said, immediately in front of the operator, and with the printed side under his eye. There is a stop-cylinder action and register stop-wheel for accurate register. The inking arrangements, which are similar to those of an ordinary cylinder machine, comprise two wavers, two inking and a ductor roller. The inkers have heavy stops to prevent them from jumping. The novel motion of the bed—which is not possible on an ordinary cylinder machine—entirely prevents the usual jar or any exceptional vibration at the end of the stroke. It also, obviously, allows the table to be worked at a greater speed than ordinarily and with much more ease.

An advantage of the "Little Wonder" not to be overlooked is that if necessary the form can be corrected on the bed of the machine—a facility often of very considerable importance. The feeding is, practically, similar to that of recent cylinder machines, the board lifting and the paper being fed to a stop gauge—the board lifting the gripper. The speed is over 2,000 per hour; but at a recent trial, in the presence of experts, the machine printed 3,145 sheets in the hour—a rate that is altogether unprecedented for a flat bed cylinder machine.

Two-Colour Machines.

In principle the two-colour machine is somewhat similar to the ordinary single-cylinder machine, but it is provided with two sets of inking apparatus, each of which acts totally independent of the other.

In regard to this class of machines generally it may be observed, that the cylinder is placed in the centre of the machine, and makes two continuous revolutions, giving an impression for each colour. The two type beds adjoin one another, each being provided with a complete inking arrangement—ductor, wavers, and inkers. The circumference of the cylinder being the same as the length of one coffin, it will be seen that when one revolution has taken place the first form has been printed, and on the second revolution the second form.

As the sheet is printed twice on the same side without being released from the grippers, perfect register is assured; and if this is not the case there is some fault in the imposition or in the placing of the forms.

Advantages.—When printing in two colours on other kinds of machines, such as a Platen or Wharfedale, perfect register in all cases cannot be relied upon, as there are so many causes that contribute to partial failure. The point-holes may be too large, or careless boys may often fail, in perfecting, to place the sheet on the pins. Added to this, the paper may be allowed to lie about and get dry before the second colour is printed; the consequence being that the sheet shrinks, and perfect register is impossible. These and other accidents may interfere to prevent accuracy of register if two-colour work is printed by two operations. In the two-colour machine, however, these incidental causes of imperfect work are obviated, the two forms being printed almost simultaneously.

Speed.—The speed at which these machines are driven must necessarily be regulated by the class of job to be worked. In heavy broadsides, where the surface of the letters is great, 300 or 400 perfect copies per hour are all that it is advisable to print, as the paper, especially if very damp, has a tendency to adhere to the form and may tear away from the grippers; nor may the damage end here, for if the

sheet be taken up by the rollers considerable delay will be caused. It is in all cases advisable to drive from a three-speed or cone-pulley, regulated to run 400, 500, and 750 copies per hour. The speed of the machine can then be increased or reduced by merely shifting the driving-band, which is the work of but a few moments.

In this class of work the rollers should be secured in the forks by a cap, or by some simple contrivance such as has been previously described, which prevents their jumping out in the event of a sheet becoming detached from the grippers. In all cases care should be taken that the grippers press tightly to the cylinder, in order that the sheet may be held secure during the printing; otherwise the work will be out of register.

Owing to the chemical composition of coloured inks it will be found necessary to wash-up much oftener than in black work. The rollers should be cleansed with turps, wiping them finally with a rag or sponge dipped in luke-warm water. In colour-work, especially in hot weather, it is advisable to have duplicate rollers in readiness.

A perforated gas-pipe should be fixed under each end of the machine, as by this means the tables can be gently heated in cold weather, which materially assists in the even distribution of coloured inks.

Notwithstanding their advantages two colour machines do not grow in public favour, as they are not found adapted for work of really superior quality.

CHAPTER VII

TREADLE PLATEN MACHINES.

General Principle—The Minerva, or Cropper—The Bremner—Powell's Improved Gordon—The New Liberty—The Golding Jobber—Godfrey's Gripper Platen.

THE distinguishing principle of the treadle platen machines is that both type-bed and platen are hinged and move away from each other for rolling and feeding, and each take part in the movement of approach for impression. In all of them the type is held perpendicularly, or nearly so, at the moment of printing.

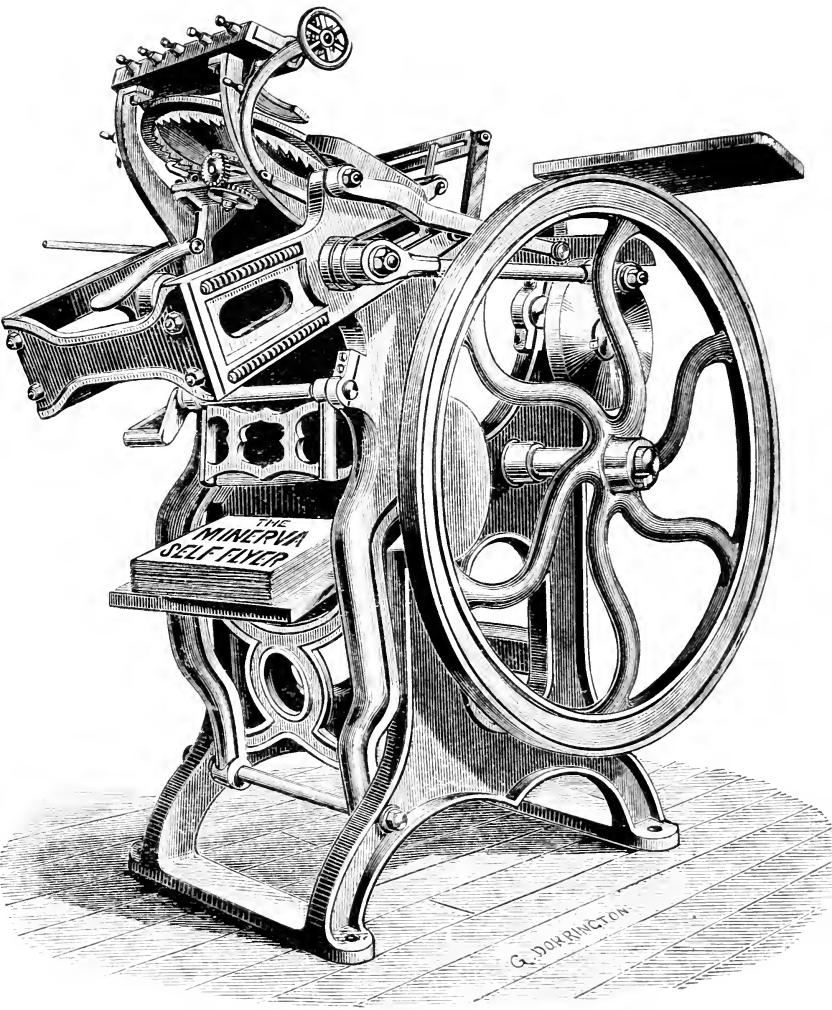
Those best known in England are modifications of Gordon's American original, introduced here at the 1862 Exhibition. The Minerva was the first made by an English firm. The Bremner and Arab machines embody some of Mr. Gordon's later improvements, and Mr. Powell has added some further details in his "Improved Gordon."

By means of these little and inexpensive machines one boy can print upwards of 1,000 copies per hour of any sized sheet or card up to half medium. Their success was general, and a jobbing-office is now not complete without one of these invaluable platens. Indeed, without their aid it would be impossible to compete with any chance of success in these times, when the universal tendency is to cheapen. The simplicity of construction of these machines is a great recommendation to their general adoption. The whole of their mechanism is open to view, and there is nothing special to demand slight and delicate movements. The springs which secure the rollers are perhaps liable to wear quickly, and duplicates should always be kept in stock

to prevent a stoppage. They can be easily and speedily replaced.

The inking has always been a difficulty in these machines, and there are, therefore, two distinct classes. In the first the distinctive feature is the revolving ink disc. The feature of the other is cylindrical distribution, very much after the style of the ordinary Wharfedale distribution. Each class has certain merits, but each has its limitations. The best machine, it is evident, is that in which the good qualities of each class are most successfully combined, and the defects most successfully eliminated. In principle, the revolving ink disc cannot be excelled. It permits of easy and quick running of the machine, which are prime requirements. Cylindrical, on the other hand, admittedly causes sacrifice of speed and dangerous friction. Hence, as a money-making apparatus, the cylindrical distribution machine is inferior to the best machines of the disc revolving class.

But in the machines hitherto used it has been found that the supply to the ink disc is unsatisfactory. There is good distribution, admittedly, in the other form of machine, gained at the disadvantage of comparatively slow and laborious work. In the disc machine—the quick and easy-running one—the means for keeping a regular supply of ink has always been defective. The defect has been sometimes met by supplying the ink to the disc with a hand-brayer, but this consumes at least ten per cent. of working time, as ink must be applied about every two dozen impressions to keep up uniformity of colour; while two or three impressions are lost at every application. If the press is run by treadle it must be stopped every time the brayer is used, or someone must stand by to apply it, in either case entailing a loss of time and labour. With all this, an even distribution is not attained, it being impossible in the nature of the case. The dilemma is to combine with the revolving ink disc some method for regularly supplying it with ink uniformly distributed over its whole surface, and which will not retard the speed of the press. This has been attempted by nearly every engineer, but the majority have travelled no further than the common small fountain, applying ink to the end of the top form roller.



To face p. 112.] Fig. 46.—The Minerva.

CROPPER'S "MINERVA."—This was the first English-made treadle machine, and maintains high rank.

For improved inking, Messrs. Cropper have recently introduced what may be regarded as an extension of the disc system. There are in the new arrangement, of which a drawing is appended, three inner discs. These revolve in the directions indicated by the arrows, contrary to that of the outer one. To meet possible objections, it may be stated that the discs are not supported by "stalks." They can be easily lifted out of their places for cleaning purposes. Connected with them are neither screws nor nuts; hence the danger of breaking is reduced to a minimum.

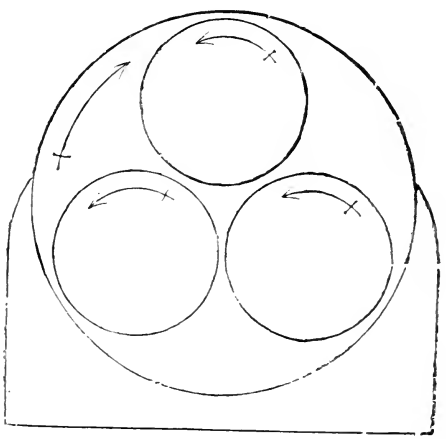


Fig. 47.—The "Cropper" Disc

The machine is now made self-flying. The sheets are fed in the usual manner, and after printing are seized by a gripper and carried down and piled face uppermost on the board at the back of the machine, as shown in the illustration. The operator has thus both hands free for feeding, and can turn out more work.

THE BREMNER.—This machine, made by Messrs. Harrild, has been especially designed for strength, solidity of impression, perfect ink-distribution and form-rolling,

combined with simplicity. The inking arrangements are upon a new principle, the distribution, by means of four separate rollers, being continuous and effective; three inking rollers pass completely over full-size forms. The platen allows more than the usual time for "laying on," and has a "dwell" on the impression, producing sharp, clear printing, without a slur. The impression may be instantaneously thrown on or off, or altered to suit light or heavy forms. The improved brake motion and striking gear is under the control of the foot, leaving both hands of the operator at liberty.

POWELL'S IMPROVED GORDON.—This Machine, as its name suggests, is the joint invention of Mr. G. Gordon, of New York, and Mr. D. T. Powell, of London. Its special appliances are:—

1.—A motion whereby the Platen may be stopped (in like manner as a Cylinder is stopped) for the purposes of obtaining a longer time to "lay"; for pointing colour work or for double rolling. A handle at the right hand side of the machine being depressed, the platen is stopped for any length of time desired. On the larger sizes the double rolling motion can be set to work automatically. Each Machine is fitted with a hand stop motion which may be used in conjunction with or independently of the automatic motion.

2.—A motion by which the pressure of the rollers on the form may be adjusted to a nicety, and by which the form may be prevented from being inked. By this device the form is prevented from being over-loaded with ink.

3.—The impression regulating arrangement, entirely distinct from the "throw off" motion, is adjusted by screws at the back. The slightest turn of a single screw makes a considerable alteration, and the impression may be altered from a thin sheet of paper to a thick card instantaneously.

On the two smaller sizes the inking is by the familiar double disc, the plate being of unusually large diameter. On the two larger sizes a flat oblong ink table is used and there are four distributors, each provided with a rider. There is also a small hand ink table attached to each Machine.

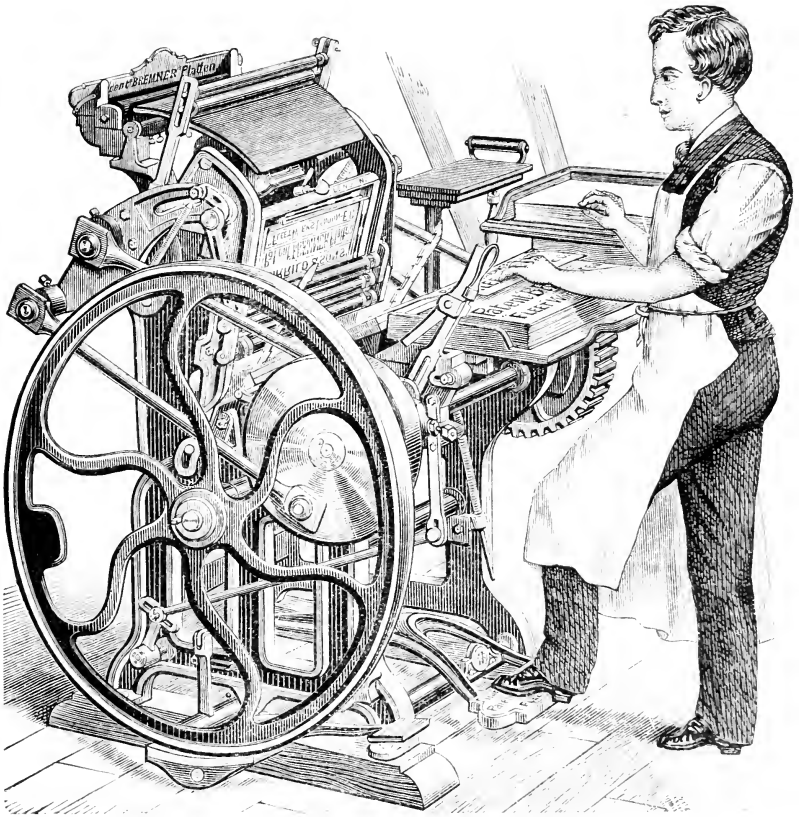


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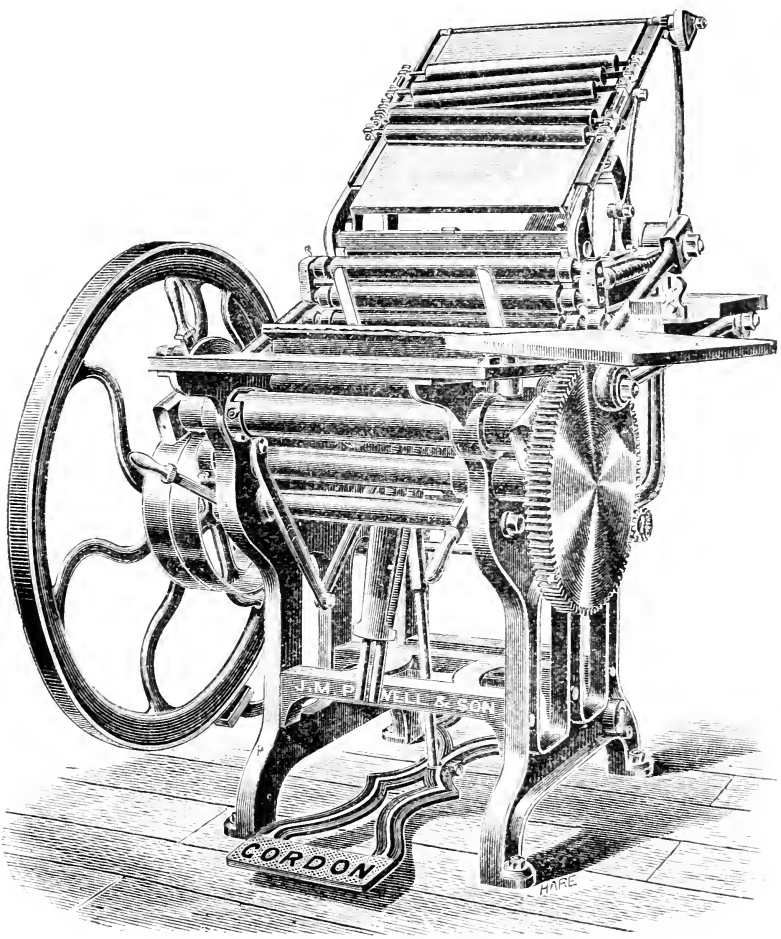
Fig. 48.—The Bremner.



No. 49.—Powell's Improved "Gordon."

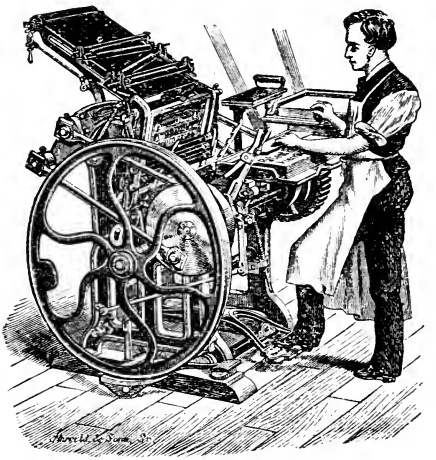


Fig. 51.—The "Liberty" Treadle Platen.

THE "LIBERTY" MACHINE, invented by Mr. Degener, an American printers' engineer, about 1867, is made by Mr. F. M. Weiler, of New York (formerly Degener and Weiler). It was introduced into this country through the agency of Mr. James Salmon, of Manchester. It has recently been entirely altered in several of its most important parts. There is a new "throw-off" motion, patented 1888. This

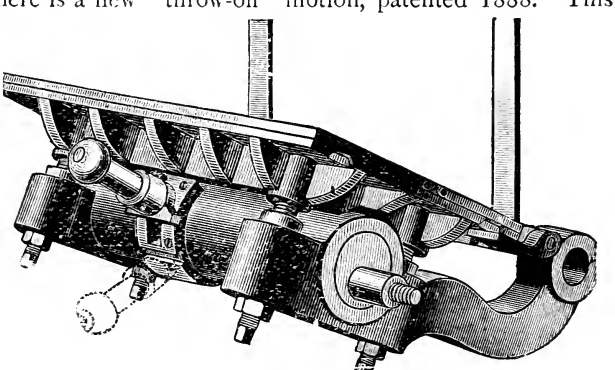


Fig. 52.—The "Liberty" throw-off motion.

is a simple but effective device, consisting of an eccentric shaft, behind the platen, with a handle in the centre. When this projects the pull is "on"; when the handle is depressed it is "off." It is close to the feeder at all times, and he can use either hand, never requiring to reach over his machine.

Another connection of the platen is the new noiseless gripper motion, patented 1887. Hardly any part of the treadle platen machine has given so much trouble and anxiety as the gripper motion. Springs have been twisted into almost every conceivable shape by which to give full command over it, with more or less success, but the printer has never yet been furnished with a device that fully meets his requirements. The grand mistake was that springs should ever have been relied on as the means of operation at all. What is known in a machine shop as the positive motion is the method by which anything of such importance should be accomplished. Such a motion, as its name imports, is a movement which executes any certain purpose desired, and does it unchangeably, while the machine is running. If constructed on true mechanical principles it will continue infallibly to do its work, and, if it operates at all, will operate at all times. Recognising this, the manufacturers of the "Liberty" had already eliminated all springs in their machine except those in connection with the gripper bar, but by a new invention even these have been dispensed with.

Instead of the springs, a cam or "shape" is used; and the grippers do their work noiselessly. The plan is simple, and the appliance cannot get out of order. The action being from the middle of the gripper frame, both grippers are of equal strength, which is not the case when worked by springs at one side. Another advantage is that the operator is enabled to bring the grippers to the platen for adjustment during any position of the machine.

In regard to the inking arrangements, the improved "Liberty" combines the advantages of the efficiency of cylinder distribution with the speed and ease of disc distribution in the following manner. Three new and special features have been adopted. They are:—1. A duct of a new style altogether. 2. A new movement of the ink disc.

3. The provision of three form and three rider rollers. The fountain has a moveable drawer regulated by thumb-screws at the back. It is always under the eye, and conveniently within reach of the feeder. The fountain roller, which is of composition, takes ink along the full length of its surface and distributes it over the entire disc. The ink disc makes twelve revolutions before presenting the same surface to the rollers. The rider rollers are placed over the form rollers, always in contact with them. During the movement of the machine they sometimes touch two at once, and the end riders revolve half a revolution in the contrary direction to the form rollers beneath them. Thus fresh surfaces are presented to each other and to the type. As fast as the form rollers give the ink to the form the riders give it back, thus ensuring an equal body of ink over the entire form. One, two, or three riders can be used, according to the work to be done, without any change of the press more than lifting them in or out.

THE GOLDING JOBBER.—In this machine, the movements are positive, without cams, eccentrics or slides. As in other recent machines, the frame, bed and braces are in one casting. This combines the greatest amount of strength and stiffness, keeping all the bearings in line, and adding greatly not only to the durability of the machine, but to the ease and rapidity of operation. An uneven floor does not affect it. The power is obtained by a compound toggle movement below the platen, which forces up the draw bars, locking the bed and platen together. The ink fountain consists of a reservoir on top of a large cylinder, supported by a strong standard secured to the solid frame of the press, and suspended over the rotating ink disc. The automatic brayer—a special feature—is a roller half the length of the disc, held in a movable frame by spring-steel arms, and operated by the rod connecting with the frame that carries the rollers. It takes the ink from the ink cylinder as the main rollers descend on the form, and as they return it is carried from the cylinder to the disc, and conveys the ink thereto automatically. The rollers are turned by a swinging movement, so that they present a different surface to the type on their upward movement, and the lower roller, that receives the least

movement on the disc, has the most on the sectional cylinder.

GODFREY'S GRIPPER PLATEN MACHINE has a stationary feeding-board, on which are slides which automatically make the proper lay. The sheet can be laid on without any precautions, and the gauges on the boards themselves adjust it, at the rate of 2,500 per hour, with no danger to the fingers of the person feeding, an important point now, when the liability of employers for accidents is largely increased.

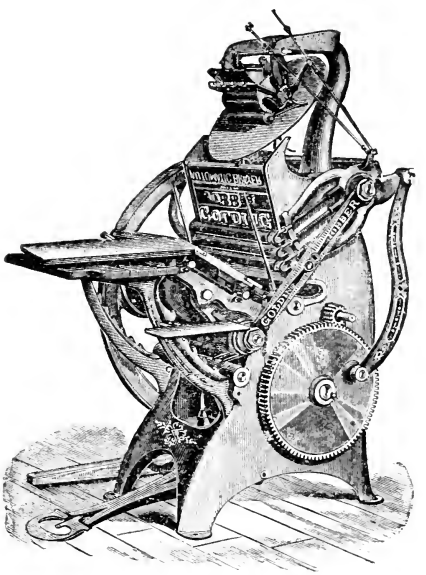


Fig. 53.—The Golding Jobber.

There are four sets of grippers moving round the platen. While one impression is being made, a sheet is taken by one of the rows of grippers, and while this is advancing another is caught, and so on. The platen is capable of being turned over towards the operator in the most convenient position for making-ready. The delivery-table is slightly sloping, as a reading-desk, in front of the operator, and unobstructed. When needed the printed sheets are interleaved with set-off sheets automatically.

CHAPTER VIII.

ROTARY WEB PRINTING MACHINES.

Varieties—The Walter—Hoe's—Marinoni—Foster's—The Wharfedale—The Victory—Foster's Placard Web—The Whitefriars—Type Boxes for Rotaries.

THE general principles of the Rotary Machine have been referred to at page 33, *ante*. The specific denominations of the machines of this kind at present used in this country are :—

The *Walter Press*, manufactured at the *Times* office.

The *Hoe Machine*, manufactured by Messrs. Hoe, of New York and London.

The *Marinoni Machine*, manufactured by Mons. H. Marinoni, of Paris.

The *Prestonian Machine*, manufactured by Messrs. Foster, of Preston.

The *Wharfedale Rotary*, manufactured by Messrs. Dawson, of Otley.

The *Victory Machine*, manufactured by the "Victory" Company, Liverpool.

The "*Whitefriars Rotary*," invented by Mr. Pardoe, London.

Various other kinds of Rotaries are made in Germany, France, and America, but we are not aware of their having been introduced into Great Britain.

It should be mentioned here, that of none of these, except the *Walter*, is there what may be regarded as any standard type. Each machine has certain individual features of its own, to which its makers adhere, but beyond that it is designed in most cases to meet the particular requirements of the purchaser. *Rotary Machines* cost from £2,000 to £7,000 and upwards, hence the expense of making new patterns for any modification called for is not shirked. Messrs. Hoe, for instance, issue a sheet of

designs of "Hoe" machines, showing about a score, at least, of varieties. Under these circumstances we cannot attempt to give a complete description of any one machine under any of the respective headings, all that we can do is to point out a few of the distinctive features of the machines of the different makers.

All that is required in the making ready of ordinary newspapers is that the stereo plates should be fairly level in thickness; and they are now cast so accurately as to give little trouble to the machine-minder. Underlaying is nevertheless sometimes required.

Care must be taken that the impression upon the edges of the plates is not sufficiently great to cut through the paper, as this is often the cause of the latter breaking in its course through the machine, being weakened by the perforations; besides which, nothing looks so slovenly in a newspaper as the heads or sides of a page being severed from the margin.

The paper is perhaps the source of the greatest anxiety, for if it is not made of sufficient strength, or is unequal in substance, it will not withstand the constant and sometimes uneven tension. The resistance offered by the weight of the reel is counterbalanced in a great measure by the nicety with which the spindle round which it is rolled is adjusted; but it is necessary to see that the bearings are well lubricated, to prevent any dangerous strain from this cause.

The operation of renewing the reels of paper is a very simple process, as in the majority of instances the supports are placed so near the ground that with the assistance of a crowbar the fresh roll can be placed in position in two minutes at most.

In regard to the qualifications of the manager of Rotary machines it may be remarked, that although a knowledge of making ready cuts, &c., is of course generally desirable, it is to a certain extent superfluous in the case of a newspaper machine-minder. What is most required of him is that he should be methodical, clearheaded, and, above all, expeditious. It is a great advantage if he is a practical mechanic, as his duties are nearly as much allied to that profession as to that of printing.

Owing to the speed at which rotary machines are driven,

slight difficulties frequently arise which require the experience of a practical engineer to deal with them. A short delay is always a serious matter, consequently facilities should be available to speedily remedy any mishap. In addition to keeping a staff of mechanics, most newspaper offices have duplicate machines ready for emergencies. A short experience will, however, soon enable the machine-minder to discover the weakest part of the machine, and duplicate wheels, bolts, &c., should be kept in stock, in order that a breakage may be readily repaired.

The *Walter Press.*—In this machine the roll of paper is placed at the end of the machine upon two standards. It is put in position in the same state as when delivered by the makers—perfectly dry. Each reel contains sufficient paper to print 5,500 sheets of the *Times*, and weighs nearly 800 lbs.

The paper passes over a tension-roller, and then over and under two damping-cylinders. The latter, which are covered with blanket, are hollow, and perforated. These cylinders are filled with sponge, absorbing the water which is injected through pipes introduced through the axle. The rapidity of the revolutions forces the water through the blanket which damps the paper. In order that the water may not remain on the surface, the paper after being wetted passes between rollers of the same diameter as the damping-rollers, and they press the moisture into the texture. This has been simplified in the machines of recent construction by the substitution of two steam damping-cylinders. To prevent any drag in the printing, the paper is then conducted between two small rollers, the surfaces of which travel at the same speed as the impression-cylinders. The plate and impression-cylinders are arranged one above the other, the top and bottom ones carrying the plates, those in the centre being used for impression. The paper passes over and under the centre cylinders; the side of the paper being thus reversed in the operation. In order that no perceptible set-off may occur, a large surface-drum of the same diameter as the second impression-cylinder works in contact with the latter, removing the ink which accumulates on the blanket. The ink thus removed is again taken by a small absorbent roller, working flush with the metal cylinder.

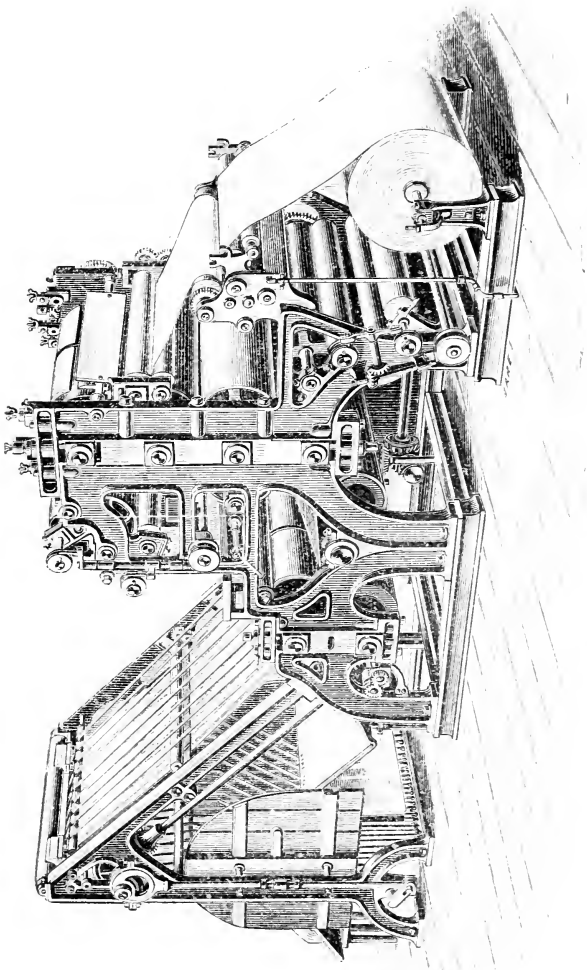


Fig. 54.—The Walter Press.

After the paper has been printed on both sides it passes directly to the cutting-cylinders. The sheets are not entirely separated, being still joined by two narrow strips. The paper is then directed up a series of tapes, which travel faster than the cutting-cylinder. At a somewhat greater distance from the cutting-cylinder than the length of the sheet are placed two small rollers, which tear the complete paper from the next following. The sheets are then conducted between two rollers, and by a dividing motion are directed perpendicularly down a series of tapes, of which there are two sets to receive the paper alternately, when the flyers strike them down to the board on either side.

In order that the sheets may not be torn as they are deposited by the necessarily quick motion of the flyers, the fingers of the latter are bowed in the middle, forming a point at the end.

Each form is supplied with a separate inking apparatus, consisting of two large distributing-drums, fed from the ductor by composition vibrating-rollers, some of which have a side motion to aid the distribution. The inking drums of the outer form, &c., are placed parallel with the plate-cylinder, and the inner form is supplied from underneath. We may mention that the ink is stored in a cellar or well below, and pumped into the ductors.

Speed and Dimensions.—The average speed of this machine is 12,000 perfect copies per hour. It is about 19 feet long, 6 feet wide, and 7 feet high.

Hoe's Machines.—Messrs. Hoe and Co. have from time to time greatly modified their machines, and continue to introduce improvements as suggested by experience. It would be difficult to detail the successive steps in the evolution of the Hoe machine of to-day from their first one, which was slightly later than the Bullock—the first practical rotary, built in 1861, and the retrospect would not have much practical value. Reference must be confined to the most perfect of the machines manufactured at the present time.

These may be divided into two classes,—first, the *single-web*, in which is printed a roll of paper the same width as the length of the journal to be produced; and the *double-*

web, in which a roll twice that width, forming two complete papers, is printed.

The most rapid *single-web* machine prints, folds, and delivers four-page papers at 24,000, and eight-page papers at 12,000 copies per hour. Supplements can be inset, and if desired pasted in as the papers pass through the machine.

The most rapid *double-web* machine is known as the Double Supplement Stereotype Perfecting Machine with Folder. It prints and delivers folded 4, 6, 8, 10, or 12 page papers at a speed of 24,000 per hour. On this machine the production of the 4 and 6 page papers can be increased to 48,000 per hour if desired, or a 16-page paper produced at 12,000 per hour. The pages on all the above papers can be pasted together down the centre margins if required, and counted as delivered in quires, of any number.

The chief peculiarity in the Hoe machines is the fact that the papers are cut off from the web after they are folded, and not before, as on all other machines. After printing, the web is cut lengthwise in the middle by a rotary knife. Its direction is then changed by passing round a bar at an angle of forty-five degrees. Each half runs on at right angles, and passes round a roller which returns it upon its course. Here the paper is brought into contact with an arrangement called "the former," which is one of the distinctive features of Messrs. Hoe's new machine. It is intended to facilitate the folding. The half-webs are carried to the head of the "formers," one on each side, two folders being attached to the machine. These "formers," being of an inclined triangular shape, placed point downwards, complete the operation of making a central lengthwise fold on the half-web. The shape of the inclined folding triangles is such that each half-web glides smoothly, but rapidly down their outer surface. The outer edges of each half-web are curved down and inward until, upon leaving the triangle, they gradually meet between a pair of horizontal rollers. The width of each half-web is now that of only a single page, but it still carries a continuous web. Before the printed newspaper is separated from this web, small pins dart out from the folding cylinder, close to the "female" part of the separating knife, and catch the web so as to hold

it until after the length of the page has been completely severed. Then a folding blade in each folder creases the paper across the middle of the page, and thrusts it between the small rollers, which give it a final fold, and hurry it on

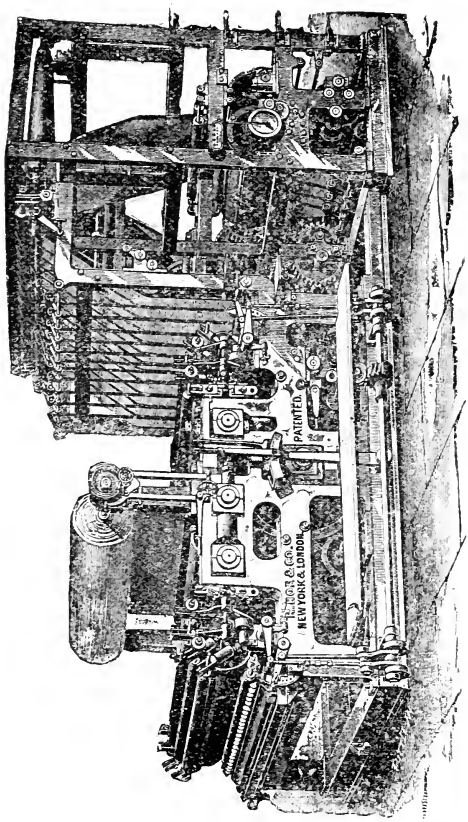


Fig. 55. Hoe's Double Web Rotary.

to the delivery. This is accomplished by the paper being grasped in a series of tapes, and the journal is then dropped half-page size upon two sets of leathern belts, one set for each folder, which carry out the papers automatically, and count them in piles.

When double-web machines were first erected, one objection to them was, the additional time necessary to cast a double set of stereotype plates, but improvements in stereotyping have rendered this objection obsolete.

The *Marinoni Machine.*—The web machines of this firm may be divided into two classes, those which print at high-speed from stereo plates of type forms, and are adapted for general newspaper work, and those for cuts or electros, and which are suitable for high-class illustrated journals and periodicals.

The Marinoni Letter-press machine, working of course from curved stereo plates, consists of four cylinders arranged immediately above each other, the two centre ones being used for the impression, the plates being fixed on the top and bottom cylinders. The ductors are situated near the plate-cylinders, which are each provided with sets of rollers, the wavers having a side motion imparted by eccentric cams. Only one set of flyers is used, and of course the sheets could not be deposited sufficiently quickly if they were taken singly. A very ingenious mode, similar to that used on other rotary machines, is adopted. The sheets are collected together on two "gathering-drums," and when five sheets are gathered a set of tapes on a vibrating-frame moves out and directs them down on the flyers, which deposit them on the taking-off board.

In order that any creases caused in the wetting may be taken out, the paper is conducted between two smoothing-rollers prior to printing, as in other machines of this principle. Beyond a man to lift the sheets from the taking-off board no labour is required, except the placing of the reels of white paper as they are exhausted. As the paper is placed on supports which stand on the floor, this is a matter of but a few moments.

These machines are made without and with folding arrangements. In the latter there is a slight alteration in the manner of taking off. The gathering-drums are dispensed with, the sheets after having been cut passing horizontally between tapes under two folding-knives, which strike them down between a set of rollers, after which the last fold is administered by another knife having a side motion. The folded sheet then passes between smoothing-

rollers, and is duly led to a box; and so great is the rapidity at which the sheets are delivered that it takes one boy's constant work to empty the receptacle.

The Marinoni Machine for Illustrated Work.—English printers have hitherto been content to do this on flat machines at the rate of about 1,200 per hour, but this new machine will give a result, approximately, equal to that obtained by printing newspapers by the rotary method, or about 8,000 perfect copies per hour. Messrs. Marinoni's machine, all included from the feed to the flyer, is only 17 ft. long, and is 6 ft. wide at its widest part, requiring no more power to drive it than most "bar" machines; for, being entirely rotary, there is no necessity for even a fly-wheel to help it to turn at the ends, or at the point of contact or "impression." The frame-work is very firm, and the whole of the cylinder shafts and bearings are strong. The reel of paper is placed near the floor, at the printing end, and goes round the blanket cylinder of the inner form after passing two steadying rollers. It then rises to the outer-form blanket cylinder, after which it runs the whole length of the machine to the cutting cylinder. This gives the ink on the sheet a little chance of drying, which improves its appearance, and the cutting cylinder having done its work, a gatherer collects four sheets and then passes them on to the flyer, which lays the printed work alternately on a board. Both forms, inner and outer, are open to the scrutiny of the attendant. The four wheels belonging to the plate and impression cylinders are adjustable for the sake of register, and also as a means to secure the overlays in a proper reciprocating position, if they should be "off" from any cause. There are six inkers in contact with the outer form. There are two sets of plates on each cylinder. In one style of the machine there are no tapes, as it has a flat delivery, but another style folds as well as prints.

Foster's Stereo Web Printing and Folding Machine is a development of the "Prestonian." In its present form it is capable of printing and folding four or eight page papers of 6, 7, 8, or 9 columns each. Another form of the machine is designed to print movable type as well as stereotypes.

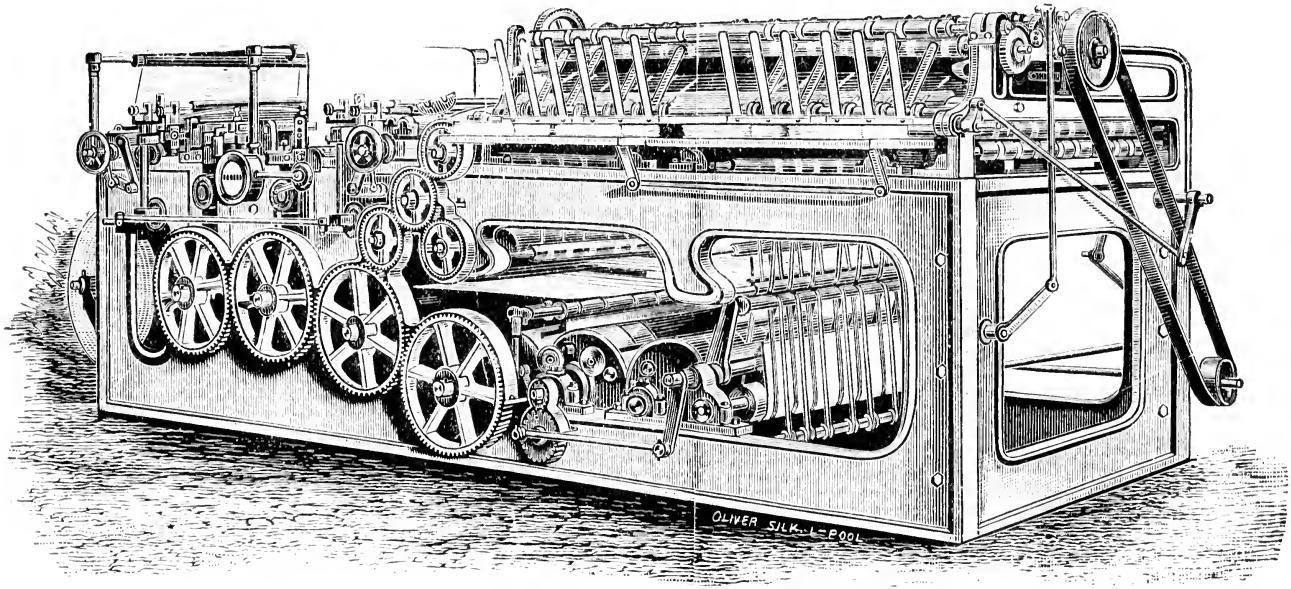


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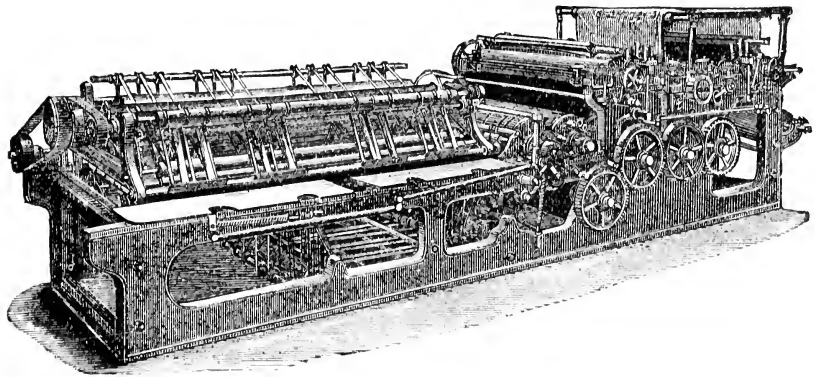
Fig. 56.—Dawson's Wharfedale Rotary.



To face p. 129.] Fig. 57.—The Victory Machine.

The *Wharfedale Rotary Machine* is very compactly arranged, nearly the whole of the parts being within reach, an advantage which cannot be over-estimated. Although not specially built to print engravings, the inking-arrangements are singularly good, each form being provided with two distributing cylinders, over which travel rollers having a reciprocity motion. The ductors are also fitted with a knife, the entire length of which can be evenly adjusted by a single screw; this is, we believe, an American invention.

There is nothing in the arrangement of the impression and plate cylinders that calls for special attention, the travel of the sheet, of course, being nearly the same in all machines.

After printing the sheet is perforated by a serrated knife, and passes into a folding-machine, which delivers two copies at a time. This folding-machine is of much smaller construction than others in use, and has been patented by Messrs. Dawson.

The *Victory Rotary Machine* was invented by Messrs. Duncan & Wilson, of Liverpool, and can, perhaps, boast of as large an amount of patronage as accorded to any web printing-machine. It is employed by many of the provincial newspapers, and the one erected for the *Globe* newspaper, which has been running for some considerable time, has given the fullest satisfaction, as certified by the testimonials from the proprietors of that evening paper. We have been assured that there are upwards of fifty-four Victory printing and folding-machines in work at the present time. The first was erected to print the *Glasgow Star* in 1870, but considerable improvements have been made in various details since that time.

The roll of paper is supported on low brackets, and on being unwound is immediately wetted by a patent apparatus, which consists of a perforated pipe from which fine jets of water are directed against the side of a long narrow trough. This has the effect of dispersing the spray, which evenly damps the paper without soddening it. After this it passes between two rollers and over a board, which helps to smooth it before printing. The paper is then directed down between the inner-form plate and impression-cylinders,

and is printed from the outer-form by being passed directly to two similar cylinders.

The inking-apparatus consists of large revolving drums, round which are fixed a series of vibrating-rollers. The ink is supplied in the ordinary manner by vibrators.

One of the specialities of the Victory machine is the folding apparatus attached. Immediately the paper leaves the outer-form cylinder it is cut lengthwise, and the paper here receives its first fold, after which, in the case of the *Globe*, which is printed in duplicate, it is cut in half by a circular knife. The remaining fold is then given to each of the papers, when they pass through separate small smoothing-rollers, and are delivered by a kind of rocking motion at the top of the machine.

As now made, the Victory Machine prints, cuts, folds, counts, and delivers the papers in dozens. The parts are so disposed as to permit of easier access to all those which may require to be attended to. The total length of the new Victory is 16 feet; the width, 7 feet; the height, 5 feet 10 inches. The machine prints, of course, from curved stereo plates, but they are not secured on the impression cylinder in the usual manner, *but by rings embracing the cylinder.* The ends of the plates are bevelled, and the rings are shaped so as to clutch and retain them. The curved plates are ribbed on the back, so that no making ready is necessary, the ribs being the length of the columns.

Special attention has been paid to the inking apparatus. The object has been to enable the machinest to change or vary the degree of colour while the machine is running. Any necessary alteration in the quantity of ink to be used is made completely across the whole surface simultaneously, and not merely partially, thus avoiding even a momentary unevenness of colour. The regulation of the ductor is independent of that of the other inking parts of the machine. The roller is adjusted separate from the adjustment of anything else, and before the machine is started. The impression of the printing cylinders can be regulated *by a simple screw*, and while the machine is in motion. They are perfectly accessible, and the minder can lay his hands on the parts in a moment, and without disturbing or

getting entangled in any of the moving parts. There is an automatic brake for the paper, and a regulating swing roller for modifying the tension, also a roller carrier to prevent the lifting of the inkers. A change of plates can be effected in two or three minutes by unscrewing a couple of screws. After being printed, the paper has to travel a very short distance—under 3 feet—before it reaches the folding apparatus. The paper is carried by tapes, and these run on geared rollers, to prevent the belts slipping, thus abolishing a frequent source of trouble and delay. The folding cylinders, which are also the cutting cylinders, are well designed. They are placed within 12 inches of the foundation stone of the machine, securing rigidity of the general framing, and steadiness of running. The gearing is covered by brass guards, to prevent accidents. The speed is 20,000 per hour for a four-page paper, and 10,000 per hour for an eight-page paper. It has hitherto been generally supposed that machines, such as the Victory, which print from the web and stereo plates, would not be suitable for offices printing only weekly papers, as the cost of casting plates, &c., would be too heavy. This has been proved to be wrong, as there are now several Victory machines working weekly papers, and the cost of producing them is said to be less than was the case with the old hand-feeding machines.

By a new apparatus the machine can be changed to cut and fold four-page instead of eight-page papers, or *vice versâ*, without stopping it. It can also be arranged to cut the eight-page paper at the head, and fold it in book form if required.

Foster's Web Placard Printing Machine.—By the use of this machine and special curved type the latest news can be inserted in contents bills after the forms of newspapers are completed, an important matter as an advertising medium. It is specially designed for printing contents bills and placards at a speed of up to 14,000 copies per hour, and prints from Foster's machine-cut curved wood type. Each machine is adapted to print bills of a given length, equal to the circumference of the printing cylinder, but the width may be readily altered.

All the before-mentioned rotaries are for printing on long rolls or "webs" of paper. A machine has, however,

been introduced to apply the rotary principle for quick work on paper in ordinary sheets. It is called the "Whitefriars," from the "Whitefriars Printing Works," at which one of its inventors is machine superintendent.

The *Whitefriars Rotary Machine* was invented by Messrs. Pardoe and Davis. The first machine of the kind was erected to print the *Weekly Budget*, and its success was so decided that the inventors were encouraged to further efforts, and these resulted in such improvements as enabled them to print ordinarily illustrated periodicals, the facilities afforded by curved electros having removed the chief difficulty of printing engravings by the rotary process. The economy in the cost of working this machine in the case of long numbers is unquestionable, and being of somewhat light construction it takes but little power to drive.

The "Whitefriars" is especially adapted for printing ordinary periodicals, with or without cuts. It consists of four cylinders arranged round a semicircular frame. The two centre drums are used for the impression, while the outside cylinders receive the plates, which are either cast or bent in a curvilinear form. The laying-on boards are directly above the cylinders, and by means of a drop-bar and tapes the sheet is passed over and under each impression cylinder and carried underneath to the flyers, of which there are two sets, one for each feeder. The inking arrangements, though simple, are effective, a large distributing-drum being employed in addition to a series of wavers. The form is inked by four rollers, each of which is self-supplying and works directly from the ink-drum.

The apparatus for fastening the plates on the cylinder is so constructed that forms of various sizes can be printed, which renders the machine additionally useful.

Capacity and Speed.—The machines now in use will print a sheet as large as 44 inches by 54. The movements throughout being entirely rotary, the number of impressions that can be printed is limited only by the speed at which the layers-on can feed in the paper. The usual number produced is about 4,000 impressions per hour.

The type cylinders of the machine can be slightly moved backward or forward by means of adjusting screws placed inside, so that if the overlay should be accidentally placed

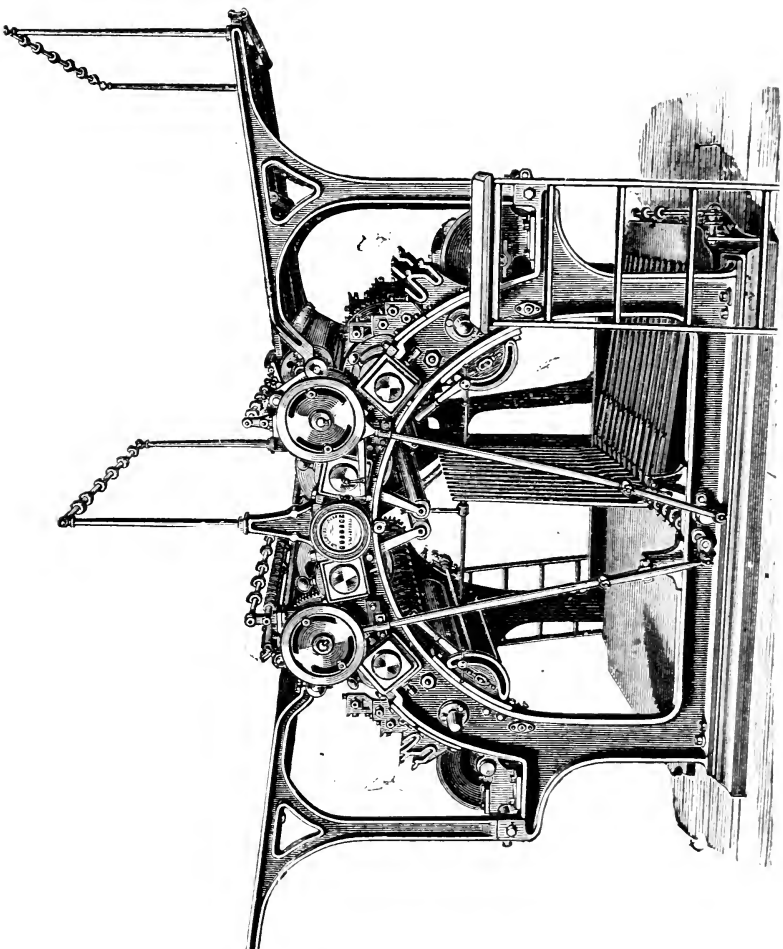


Fig. 58.—The "Whitefriars" Rotary Machine.

too high or too low the defect may be remedied without the removal of the blanket. The "Whitefriars" can also

be used as a one-sided machine, and is well-adapted for working the inner form of, say a newspaper or illustrated publication of large circulation.

The "Whitefriars" is also made to print from the continuous roll of paper, as well as by sheets fed in the ordinary way. From the reel as many as 8,000 copies per hour can be produced, and a great advantage claimed is that the alteration from one method of feeding to the other can be made in a very short space of time. Several of these machines have now been working successfully for some time.

The need of a means of very quickly issuing results of races and other events of public interest by evening newspapers, has led to the introduction of a little device which may best be mentioned here.

Type Boxes for Rotary Machines.—Mr. Curthoys, of Wolverhampton, and Mr. Petch, of Middlesbrough, have independently invented methods nearly alike, whereby, after the curved stereo-plate for the web machine is duly cast and finished, the latest news can be inserted with the utmost possible rapidity. The page of type is so made up that a blank is left where the anticipated news will fall. A curved stereo-plate is then cast in the usual manner and the blank space is cast out. A little box is contrived which can be put into an ordinary composing-stick, and the instant the result of the race is known in the office it is set up. The box is clapped into the plate as it is laid on the machine, which is at once started. No screwing up or adjustment beyond accurately spacing out the lines is necessary. The printing from the type thus inserted, although not so regular as that from the plate, is perfectly clear and legible. The plates are about $\frac{3}{8}$ in. in thickness, and the type and the box together must not be thicker than that. The type may be cut down or special type procured. The plate is rebated. An ingenious catch, of the nature of a quoin, having a projecting tongue, acted on by a spring, which runs into a groove on the side of the box, effectually secures it.

Another method may be adopted for giving the result of any contest. The competitors' names can each be set up in

lines to a certain measure, stereotyped, cut up separately, and then instantly arranged in the order of winning. The figures 1, 2, and 3 at the end always stand; they are cut in brass on a piece which is partly rebated under the stereo-plate. At the other end is the brass spring catch, also rebated in conformity with the lines themselves. The cast line method is by far the quicker of the two, but requires more trouble, which, however, being done in advance, does not retard the printing when the news is obtained.

Petch's apparatus uses a small box with a tapered end. At the opposite end are two projecting catches, actuated by a spiral spring; the tapered portion of the chase or box is placed into position in the recess in the plate, like a flap or hinge. When the item of news arrives it is instantly set up in type (no previous preparation being required), and placed in the box, and when secured, instantaneously pressed into position. The recess which is prepared can be filled up with any item of a commonplace nature. When the expected intelligence comes this par is quickly released, and the other inserted.

CHAPTER IX.

WAREHOUSE MACHINES AND MISCELLANEOUS APPLIANCES.

General Arrangement—Drying—Gill's Hot Rolling Machine—Cutting Machines—Gathering Machine—Wetting Machines—Blanket Washer—Roller Spring Adjustment.

THE proper arrangement of the WAREHOUSE is of more importance than most printers acknowledge. This part of an office is generally supposed to be the non-productive,—a department upon which the less bestowed in labour and space the better. When the cost of a job is estimated, it is very seldom that the expense of counting, drying, pressing and packing up is taken into consideration. Composition, paper, and print are the items which are calculated. As is well known, the expense of warehousing is a considerable addition to the total cost, especially when the whole is done in a proper manner.

The warehouse, or that portion of the printing-office used in the clearing and packing-up of work, must be both light and dry. Counters should be erected in the lightest positions for this purpose. When gathering is done, a considerable amount of bulk-room is required. This can be economised, however, by the use of Howe's gathering machine, to which we shall refer hereafter.

Above all things, cleanliness should be insisted upon. Clean work is deposited in all directions, and if dirt or dust

is allowed to accumulate, many sheets will be spoiled, and in the case of short numbers, will possibly render the delivery deficient of the proper amount.

If the warehouse is situated above the machine-room, it is a good plan to have a small lift, say capable of holding two or three reams of paper, with an automatic reversing gear. The work can then be deposited in the machine-room by single reams, and lifted out by the counter in the warehouse above. This will save expense as well as spoilage by careless porterage.

Although a small matter in itself, the chief warehouseman should be a fair caligraphist. The neat labelling of work is always characteristic of careful packing, besides which the clearness and precision of delivery-notes favourably impresses a customer. Printed labels, however, are much to be preferred.

Although badly-printed work can never be made to look well by any amount of drying, pressing, or rolling, the finest machine-work may be speedily spoiled by carelessness or inexperience on the part of the warehouseman. Much spoilage is caused by set-off while printing, and work is also spoiled by the same cause even after it has left the machine-room. This is owing to various causes, the most prolific perhaps being the pressing of the sheets before they have been properly dried. Work on highly-glazed paper must be so stored after leaving the machine as to prevent any undue pressure. If it is piled up, ream upon ream, the sheets will be spoilt, as in rolled paper the ink lies upon the surface, the paper being too hard to allow of the ink being absorbed, as in the case of ordinary printing.

Various means are employed in the drying of work, the quickest and most effective being by hot air or steam pipes. The room chosen for this purpose should be entirely constructed of brick or other material, to lessen the possibility of an accident from fire. The work is generally hung upon a kind of wooden frame having cross bars at stated intervals. These frames are hooked upon iron bars, and are so loosely hung that they can be shifted along any portion of the supporting rods. Thus a large number of these drying-frames can be pushed close to one another in a comparatively small space, as they are filled with sheets. The

work should be hung in quantities of about half a quire, but this must be regulated by the description of work, the time that can be allowed, and the heat applied. It is never advisable to allow the temperature to become too high. Cut work is sure to suffer, the ink being liable to turn to a brown hue, and if the paper is hard in texture, and extra pressure has been put on at machine, the utmost difficulty may be experienced in entirely taking out the marks of the impression even by the hydraulic press. The temperature of the drying-room should be about 100° or 120°.

In offices confined for space the work is often hung on poles stretching across the warehouse near the ceiling. Although this is frequent, it is objectionable from various reasons. The sheets are apt to become soiled from the necessarily long exposure, and the danger of fire is greatly increased. Besides this, the warehouse lacks that appearance of tidiness which ought to be a characteristic.

Superfine cut work must be dried by cold air. This is of course a much slower process than by the hot room, and takes a great deal of space. Horizontal racks, erected one above another, are best suited for this purpose. Not more than two or three sheets should be laid together, in order that they may be properly exposed. If the cuts are exceptionally heavy the set off sheets should remain in till the work is partially dry, when they can be run out.

Before the work is pressed it must be thoroughly dry. This can be easily tested by putting a piece of white paper on the text and rubbing down with the nail. If the work is insufficiently dried, the glaze-boards will be so soiled that they cannot be again used until thoroughly cleaned, a long and unpleasant job. This is supposing that the sheets have been put in singly; but if two or three have been placed together between two boards the probability is that the whole will be entirely spoilt by set-off.

Glazed Boards are made of various sizes and thicknesses. Although they are more expensive we would advise the purchase of the thicker make, as the thin ones are liable to become quickly torn or otherwise damaged. Cheap boards should be avoided, as they are frequently of uneven thickness, and if great pressure is placed upon them

in the hydraulic press a serious break may occur. We believe that the heads of many presses have been broken from this cause.

CLEANING WORK.—Although the work should be delivered from machine perfectly clean, this is not always the case. Small "blacks" are frequently present, caused by catches or high furniture. When the paper is somewhat thick in substance very fine glass or sand paper may be used. But when thin this cannot be done, or the paper will be rubbed into holes.

Plate paper is very liable to soil, and if the work be very choice it is advisable to examine every sheet. Any dirty marks caused by careless handling, &c., can be cleaned off either by stale bread, ink-eraser, or india-rubber. In all cases the above should be used as little as possible, as they take the gloss off the paper wherever applied.

For putting-in and taking-out the work from the glazed-boards, benches should be provided amply large enough to take the largest-sized sheet that is likely to be pressed. If the paper hangs over the bulk, the edges will either be soiled or torn by the boy. Several persons may work together along the same counter; but we would advise the most careful to be selected for the lifting of the glazed-boards. These are expensive, and more damage is done to them in this process than in the placing and removal to and from the press.

Large pieces of wood should be placed on the counter, against which the work may be evenly laid. This will save ultimate knocking-up, which unless carefully done damages the edges of the sheets.

The pressing of partly-dry work, though practised to a great extent, is a very reprehensible practice. The set-off is avoided by the slight pressure, but no matter how smooth the sheet may appear when taken from the boards, the impression will surely reappear as the work gets dry. When time is all-important, the Hot-rolling Machine may be used with advantage.

Before rolling printed work the ink must be thoroughly dry. If this is not the case it will smash or spread, and the work will present a blurred appearance. The rollers will also become soiled and the work spoilt. In rolling

work great judgment is necessary in the application of the pressure. It should be remembered that this process always thins the sheet, even when comparatively slight pressure is applied. All papers are not adapted to rolling, especially when esparto has been used in its composition. Tiny yellow specks will appear on the surface and altogether spoil the general appearance of the work. Again, though paper may feel thick, and when held to the light appear perfectly clean and white, when rolled it may possess dull grey spots all over the surface. Common papers should never be rolled, and it is as well to advise the stationer when paper is to be subjected to this process. Work is sometimes printed in quadruple and cut up prior to pressing. When this is the case, great care should be taken that the ink be dry, especially on cut-work, or it is liable to set-off from the pressure exerted in the cutting machine.

Although screw-presses are still used, it is impossible to obtain from them that pressure which is necessary in the proper finishing of work. Hydraulic presses suitable for printers are made up of various sizes up to quadruple-demy, and can either be pumped up by steam or hand power. When a number are used it is advisable to work the pumps by steam. This is mostly done by an eccentric fixed to the shafting. A single pipe can be made to supply any number, by having a joint at every press fitted with a screw valve, which can be opened or shut at will.

With careful usage the hydraulic press seldom requires repair, as there is nothing in its construction that is liable to much wear, excepting the leather washers. The duration of time these last can hardly be stated, as it depends, firstly, upon the quality of the material used, and secondly, upon the power exerted and the amount of work done. We have known them last in good condition for two years, and also to require renewing in as many months. The leather itself is inexpensive, but the table and ram have to be lifted from their positions, which of course involves some amount of labour.

The ordinary rolling machines are gradually being superseded by those in which the sheet is passed directly between the cylinders, as in the Gill and Heim machines. The great expense of the zinc-plates used in the old machines certainly

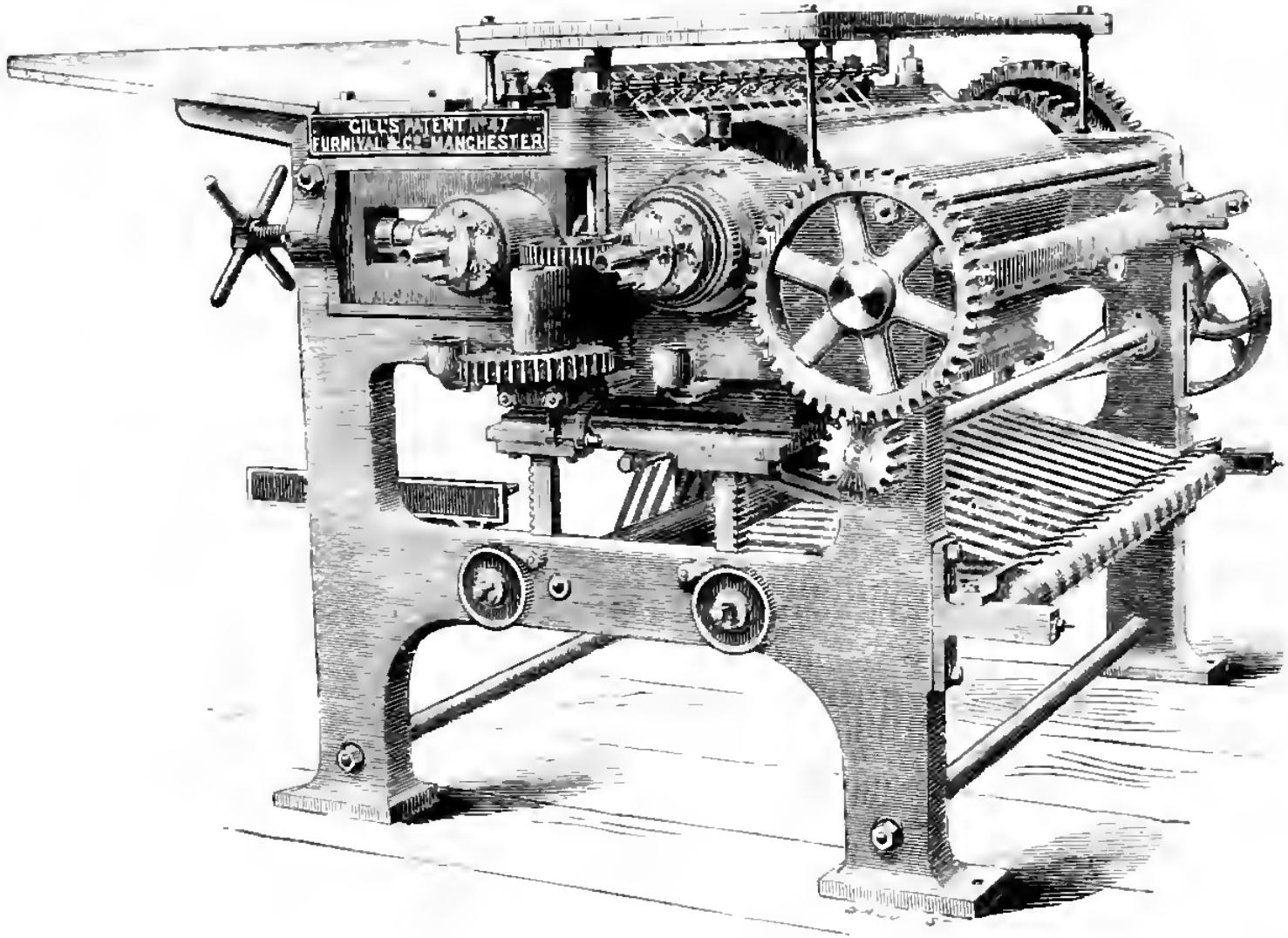


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Fig. 59.—Gill's Hot-rolling Machine

militates against them, besides which the power required for driving is incomparably greater. If both ends are worked, four or six boys are required, whereas in the new machines two are sufficient. The zinc-plates should be kept for a certain sized sheet; otherwise the paper is apt to become marked.

We have found it advisable to carefully examine paper rolled on zinc plates, in consequence of the liability of the plates to peel and leave pieces impressed on the paper. If these are not discovered before printing, serious batters will occur.

Paper is generally wetted prior to rolling, which softens the texture, and thus renders it more liable to take a surface, and fits it for immediate printing. If it is allowed to stand too long after rolling, it will become hard and tinny, and more trouble will be experienced in the printing.

GILL'S HOT-ROLLING MACHINE is now largely used for the rapid finishing of work direct from the printing-machine, and has been considerably improved since its original introduction. It dries and presses or rolls the sheet in one operation. The cylinders are made of polished steel, and a small steam-pipe passes through the centre of each. It is only necessary to admit the steam for a quarter of an hour twice a day, as they are very thick, and retain the heat thus imparted for a considerable time. The cylinders are cleaned by means of a long pad filled with scraps of sponge underneath each. This pad is laid in a long trough filled with lye, and presses against the under part of the rolls, removing all the ink that may have adhered from the sheet. As the hot rollers cause a slight evaporation, the troughs have to be occasionally supplied with lye, which is poured into a funnel-shaped receptacle and carried to the pad-trough.

The rolls are finally wiped or cleaned by a long strip of india-rubber, which presses lightly against the surface. Thus the cylinders are cleaned and wiped after each sheet is rolled. The accumulation of ink deposited in the trough by the pad should be periodically removed, or the cylinders are liable to become soiled.

Although not suitable for superfine cut work, in consequence of the application of sudden heat, which has a tendency to discolour the ink, it is eminently adapted for

all kinds of general and jobbing printing, wrappers to books, &c. The pressure can be regulated by powerful horizontal screws, so that the paper can be rolled, if ordinary care be used, without being thinned. The later Gill machines have a larger box for the steam in the middle of the cylinders than at the sides. This was found necessary to counteract the tendency for greater expansion at the ends. The great demand for these machines speaks of the universal favour in which they are held.

From 1,000 to 1,500 sheets per hour can be dried and surfaced by Gill's Hot-rolling Machine, and we may add that the power required in the driving is very small, the whole of the motion being purely rotary.

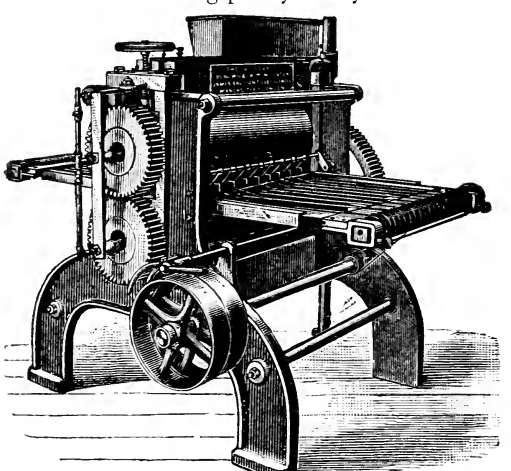

Fig. 60.—Duncan & Salmon's Hot and Cold Rolling Machine.

DUNCAN & SALMON'S PATENT HOT AND COLD ROLLING MACHINE of which an illustration is annexed, has been recently introduced to meet the requirements of the trade for a first-class Machine at a fair and reasonable price. It will press, dry, and finish work direct from machine or press. It can be heated by gas or steam, whichever may be required, and the impression regulated to the greatest nicety. Mr. James Salmon, Blackfriars Bridge, Manchester, is the manufacturer.

THE CUTTING MACHINES now manufactured are so uniformly excellent that little difficulty will be experienced in selection.

Most of the recent Cutting Machines are on the self-clamping principle. The loss of time involved in determining the position of the cut by screwing down the clamp, the manner universally adopted, is altogether avoided. In one type of machine this is accomplished by the clamp

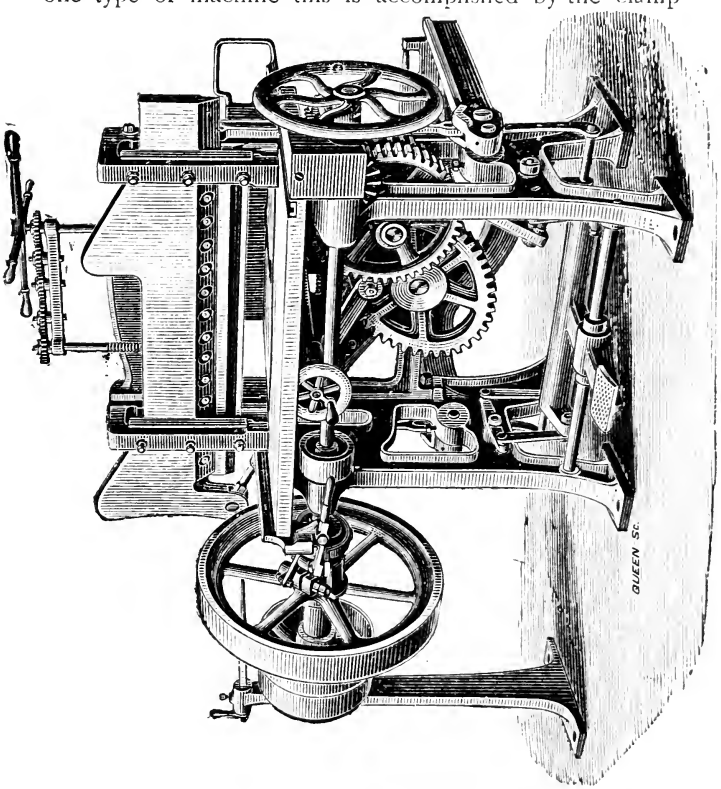

Fig. 61.—Furnivall's "Express" Cutting Machine.

itself, which is at one time moved to the position it will occupy during the descent of the knife by levers underneath the table, which can be worked by the foot. A balance-weight being fixed to the levers, it is automatically raised to its original position when the foot is removed.

This is altogether independent of the arrangement which fixes the clamp when the work is ready to be cut. The paper is really held by pressure exerted by heavy iron weights dropped into a pair of parallel bars, acting as levers, at the back of the machine. As these weights can easily be adjusted, the pressure exerted by the clamp can of course be regulated.

The levers are governed by a bell-crank on the end of the shaft driving the wheel which moves the knife. The crank is attached to a movable steel bar, having an opening almost its entire length, and in this runs a small tumbler attached to the frame holding the weights. By this means the levers are allowed to govern the pressure, as when the clamp can fall no lower on the paper, the tumbler on the arm attached to the lever-bars merely travels upwards in the slot before mentioned. On the return of this arm, however, it lifts the weights, and the clamp rises from off the paper.

Thus it will be seen that the machine has its work, as it were, divided, instead of, as in some other machines, having but to raise the knife when the cut is made. Thus, when the knife descends, the clamp is being lowered simply by the action of the weighted frame; but immediately the cut is performed, the clamp together with the weights are lifted by the slotted arm attached to the bell-lever.

HOWE'S GATHERING MACHINE.—As many publishers insist that volumes shall be delivered by the printer collated in perfect books, we may call attention to the above addition to the appliances of the warehouse. It somewhat resembles in appearance the roundabout, so common at fairs, and consists of an upright centre pillar reaching from the floor to the ceiling. A wide table is fixed round about 2 feet from the ground, and supported by iron rods to the main pillar. The sheets are laid on this table in consecutive order, and the boys are placed near the edge and facing a small table. As the machine moves slowly round each boy takes a sheet, and if the whole of the work be laid on the round table a perfect copy will be collected at every revolution. This can be increased by multiplying

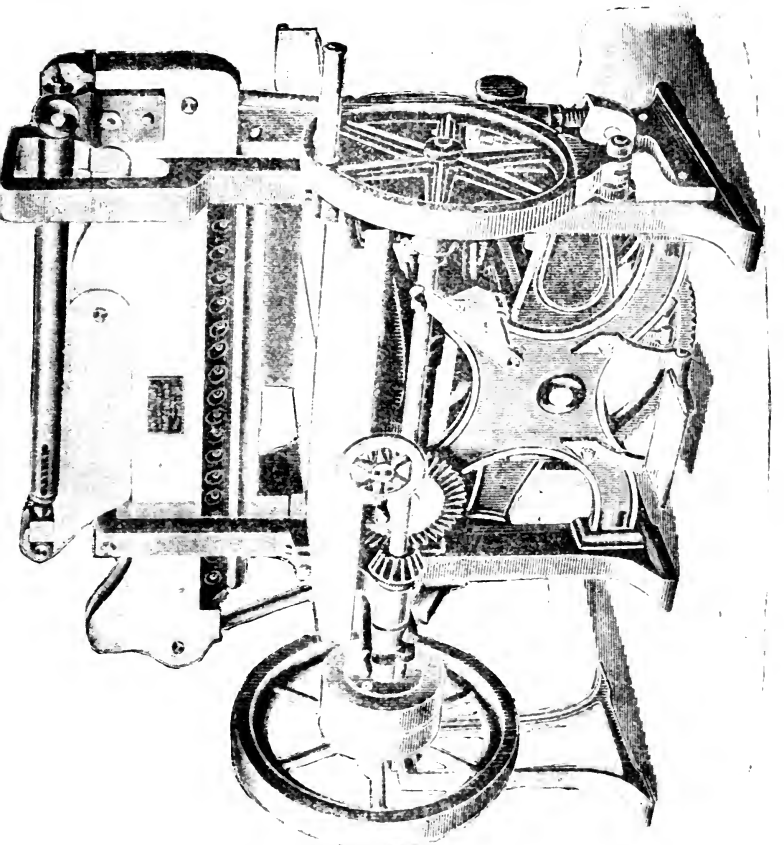

Fig. 62. Salmon's "Victory" Cutting Machine.

the number of operators; and, in fact, with twenty boys as many perfect copies may be collected at every revolution. It requires but little power to drive, and the motion is conveyed to the centre pillar by the ordinary bevel wheel. The inventor is Mr. Howe, the manager of Messrs. Eyre & Spottiswoode's Bible Printing Office at Shacklewell.

WETTING-MACHINES.—We have already referred to the machines employed for wetting the reel of paper, and must now call attention to those specially constructed for damping separate sheets. Various appliances have from time to time been devised, but the one most in favour consists of an iron trough, in the centre of which revolves a large wooden cylinder covered with felt. Five thin rollers are fitted round the large one, which carry a series of endless bands. The trough itself is half filled with water, so that every portion of the cylinder is immersed in turn as it is revolved. The sheet or sheets of paper are fed in between the tapes taken round the cylinder, and passed through the water, being delivered at the other side. The machine may either be turned by hand or steam power. As many as thirty reams per hour can be wetted by this means, two boys only being required. But little space is necessary, and the sloppy mess incidental to the operation of wetting is obviated.

Another capital appliance consists of an arrangement somewhat on the same principle as the shower bath. A square tank sufficiently large to cover the largest sheet of paper to be wetted is fixed above the head of the operator The bottom of the tank is usually made of zinc and perforated with small holes. The supply of water to the tank is regulated by a ball-cock. The water is allowed to fall through the perforations every five seconds, affording time for the wetter to take the required number of sheets from a stack at his side and place the same upon the heap immediately underneath the tank. The fall of the water is regulated by a chain or thin band, worked by an eccentric on the nearest revolving shaft.

Where this appliance is adopted it is advisable to protect the legs of the operator by large boards sloping inwards. It is also necessary that a well or drain be under the paper to

carry off the water, which may be pumped up to the tank again if the well be used.

It will be found an excellent plan to provide a truck, or flat board on four small substantial wheels, upon which to lay the paper being damped, otherwise some trouble will be experienced in its removal when the heap becomes large. The whole may then be wheeled out of the way, and remain till in a fit condition for use.

A man is able to wet about 110 reams of quadruple demy in a day by the above appliance. Messrs. Harrild & Sons are the makers.

ANNAND'S BLANKET-WASHING MACHINE consists of a horizontal cylinder, the surface of which is sufficient to take on the largest blanket. This cylinder is partly immersed in a trough containing any suitable washing liquid. At one part of the surface of the cylinder is a longitudinal slit, into which the end of the blanket to be washed is inserted, and by moving a handle the edge of the blanket is instantly secured to the cylinder. Above the latter, and parallel with it, is another cylinder or roller of small diameter, which is pressed upon the larger one by powerful springs. A slow revolving motion is given to the cylinders by suitable gearing. When the machine is started, the blanket is wound round the large cylinder, and the washing liquid is alternately absorbed by the cloth and squeezed out of it by the upper roller. After adjusting the blanket, the machine requires no further attention until the blanket is ready to be removed, ten minutes being sufficient to wash the dirtiest blanket, at a cost of less than one penny for soap.

Printers' blankets, as is well known, have to be laid aside when they get uneven through the wearing of certain parts, the margins still retaining their original thickness. In washing them by scrubbing them the tendency is always to wear them thinner at one part than another, and brushing raises a soft nap, which shows a heavy impression without giving solid printing. Mr. Annand's machine avoids these defects, for the rolling or wringing action between the two parallel surfaces does not wear the blankets like other forms of washing, because there is no friction on the fabric. It

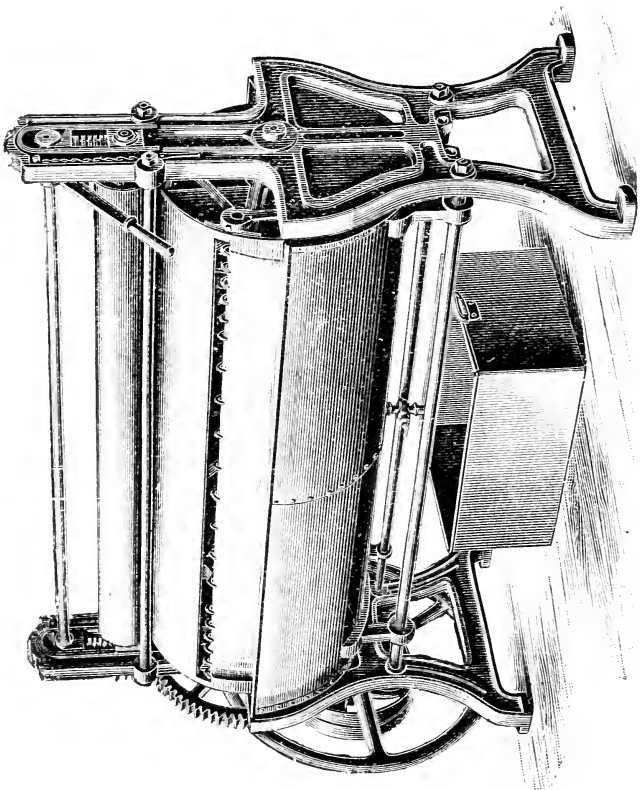

Fig. 63.—Amand's Blanket Washer.

does not raise the nap, and it will roll and compress the high parts level with the rest of the blanket. Consequently blankets thus washed last much longer, and owing to the good condition in which they are kept do not cause the plates to cut the paper at the margins. There are other uses of the machine. For instance, by using cotton cloths instead of cotton waste in the machine and engine room, a great saving can be effected. These cloths when dirty can be washed in the machine—a gross at a time—and may be used over and over again. The blankets used in the stereo department can also be washed by the machine.

NOBLE'S ROLLER SPRING ADJUSTMENT can be fitted to the roller forks or brackets in a few moments. The spring renders riders, quoins fitted in the forks, &c., unnecessary, as by the use of the apparatus rollers are kept down to the form with a sufficient pressure to obtain a fair inking, preventing the jumping of the rollers and consequent friaring of the form.

Other machinery used for printers—the employment of which grows daily more common—will be found described in various volumes of "Wyman's Technical Series," more especially in the works on "Stereotyping and Electrotyping"; "Colour Printing"; "Zincography; or Process Blockmaking"; "Practical Manual of Typography and Reference book for Printers"; and the "Grammar of Lithography," all of which are recognised as standard works of reference indispensable to every printer. For motors, "How to manage a Steam Engine," a volume of the same series may be consulted. A full list of all the books comprised in the "Printer's Library" will be found on a subsequent page of this volume.

CHAPTER X.

CONCLUSION—CHRONOLOGY.

WE have now endeavoured to describe the leading principles to be found in almost every kind of letterpress printing machine; to show how those principles have been applied; how different applications have been modified from time to time: and the most recent developments to which the improvements detailed have gradually led. In no case has a complete description of any single machine been attempted. To do this properly would require a large volume, and it would involve endless repetition and much duplication. It has been our aim, on the other hand, to resolve the various machines into their elementary parts, and to trace the progress of invention as it has affected the design and the relations of those several parts. In order, however, to remedy some of the inevitable disregard of chronological sequence which this plan has entailed, we append a table showing the dates of the introduction of the leading machines that have been invented.

It is believed to be the first list of the kind compiled, and some difficulty was met with in fixing the dates of several inventions. This arose from the fact that it has happened more than once that an improvement has been devised and even patented by one inventor, but never carried into practical effect until many years after, and then by some one else, perhaps in a different form, although the principle has been identical. This explanation is thought necessary as some of the dates may, at first sight, appear erroneous.

Single Cylinder Machines, printing one side only :

Nicholson's projected Machine	1790
Koenig's first cylinder machine	1811
Koenig's two-feeder	1814
Applegath & Cowper's *Times* four-feeder	1827
Belper Machine (jobbing)	1835
Middleton two-feeder	1845
Main's machine (jobbing)	1850
Soulby's Ulverstonian (jobbing)	1853
Dawson's Wharfedale (book and jobbing)	1858
Ingle's machine (jobbing)	1858
Bremner's Belle Sauvage (book and jobbing)	1859
Harrild's Improved Main	1867
Bremner's improved Belle Sauvage	1869
Parson's *Graphic* two-feeder (cuts)	1874
Newsum's Anglo-American (cuts and hard packing)	1882

Perfecting Machines :—

Koenig's	1814
Cowper's	1816
Cowper & Applegath's	1818
Dryden's drop-bar	1820
Napier gripper	1824
Anglo-French	1850
Dryden's Anglo-French	1860
Davis's	1880
Dawson's	1884
Payne's	1885
Newsum's	1886
Sauvée's (Marinoni)	1886

All of the above have two impression cylinders, and they may be distinguished according to whether they have the intermediate register drums, *e.g.*, Applegath & Cowper's, or, grippers, *e.g.*, Napier's and the Anglo-French.

Mark Smith's	1884
Dawson's	1885
Payne's	1885

The above form a new departure in the construction of perfecting machines, having only one cylinder. This type of apparatus is, as will be seen, of quite recent introduction.

Platen Machines :—

(*a*) Large horizontal platens for bookwork.

Koenig's experimental machine	1804
Koenig's screw platen	1810
Napier's platen	1830

Tilghman's platen for web-paper* 1878
Kritch's platen for web-paper* 1880

(*b*) Vertical platen machines with treadle arrangements for job-work.

Cropper's Minerva (Gordon's) 1860
Bremner's platen 1870
Godfrey's gripper platen 1883
Powell's improved Gordon 1885

Rotary Machines :—

(*a*) Printing one side of the paper only.†

Nicholson's project 1790
Bacon & Donkin's pri-matic machine 1813
Cowper's curved stereo machine 1816
Rowland Hill's 1835
Napier's projected rotary 1837
Applegath's vertical cylinder 1848
Hoe Lightning type-revolving press 1857

(*b*) Perfecting rotary machines.

Bullock web machine 1865
Walter press 1866
Marinoni single sheet machine 1867
Victory web printing and folding 1870
Whitefriars rotary for single sheets 1870
Foster movable type web rotary 1871
Hoe rotary web 1873
Marinoni rotary web 1873
Ingram rotary web for cuts 1876
Dawson's rotary 1882

Machines in which no new distinctive feature appears, and are chiefly improvements on previous patterns, are omitted from this list. Many of these, however, are of great value to the printer, being the result of successive experiments and of long experience, although in the majority of cases they are chiefly copied from previous machines.

* These are not strictly belonging to this class, nor do they belong to the second class, although they come under the heading of platen machines.

† The preliminary experiments on the principle of the calico printing machine are omitted here, as they were not productive of paper printing machines.

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